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ASTM BULLETIN

"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

TELEPHONE—Rittenhouse 6-5315 R. E. Hess, Editor R. J. Painter, Associate Editor CABLE ADDRESS—TESTING

Number 159 JULY, 1949

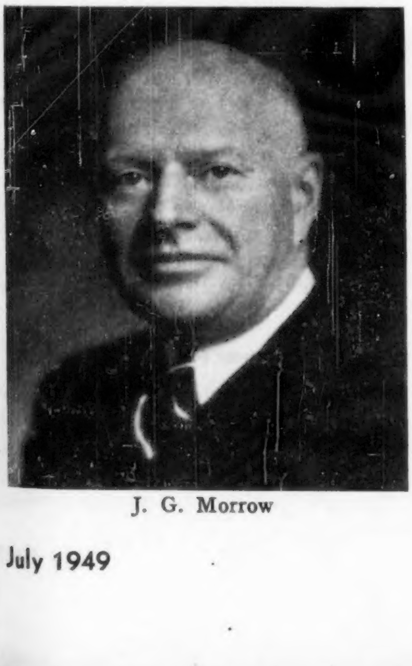
Many Accomplishments at 1949 Annual Meeting

Several Notable Symposiums, Many New Standards, Much Research Work Planned

WITH a registered attendance reaching the second highest figure recorded, upwards of 75 new tentatives, and many revised standards adopted, the largest number of committee meetings ever held during an Annual Meeting week (some 450), and a great deal of new work reported, the 1949 Annual Meeting, the fifty-second in the Society's history, was another outstanding affair. Coupled with the technical program and meetings were certain social events including—for A.S.T.M. at least—an unusual dinner with no business functions, the first official luncheon yet sponsored, and an interesting ladies' entertainment program. The dinner and ladies' program were sponsored by the Philadelpha District.

A perusal of the material which follows will give a sketchy picture of some of the outstanding technical sessions, and one reviewing the more extensive material on committee activities must reach the inevitable conclusion that a tremendous amount of standardization and research work was accomplished.

New President



J. G. Morrow

Standardization Accomplishments

One not too familiar with the Society's standardization operations might conclude that a comparison of the accompanying table summarizing actions taken at the Annual Meeting with similar tables for earlier years could get a true evaluation of the results of the Society's work in this field. However, during recent years the Administrative Committee on Standards in the interval between annual meetings has been called on more and more to approve tentatives and revisions so that the over-all picture of a year's accomplishments would have to include the actions by that group. Nevertheless, the approval of 77 new tentatives representing "new" work, the adoption as standard of almost 100 previous tentatives, and numerous other revisions as indicated in the table, reflects intensive technical committee work carried out during the year and places this meeting among the top annual affairs for standards work accomplished.

In a separate article in this BULLETIN there is a complete list of the *new and extensively revised* tentative specifications and tests. Many members are interested especially in the serial designations that have been assigned.

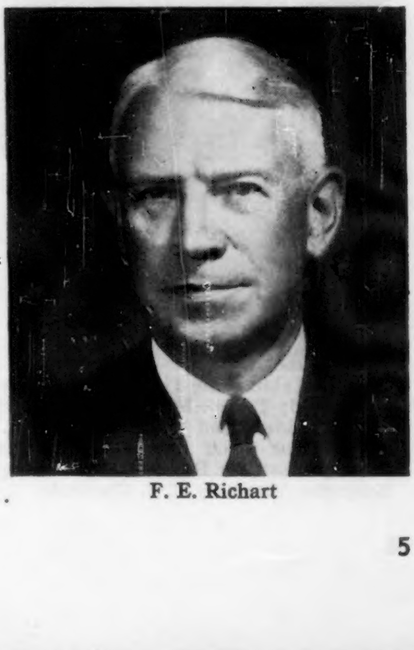
Standards Published

All of the new and revised standards acted on at the meeting will eventually be published in the big 1949 Book of Standards to be issued quite late in the year in six parts. (On file at Headquarters are the members' instructions concerning the Parts that they wish to receive.) In the meantime, many of the specifications and tests will appear in the special compilations of standards on which work is under way. Many of these compilations, for example, those on petroleum, textiles, and others, will be issued in the Fall, and a determined effort is made to issue separates of the standards as soon as possible. All of the new tentatives were preprinted in the respective committee reports, and it is presumed the members particularly interested have requested copies of these reports.

New Officers

Results of the letter ballot on election of new officers were announced at the Luncheon by the Chairman of the Tellers' Committee, E. J. Albert. The newly elected members of the Board of Directors who were present were introduced, as was the new President, J. G. Morrow, The Steel Company of Canada, Ltd., who spoke briefly. The new Vice-President, Professor F. E. Richart, University of Illinois, was absent from the meeting because of illness. Photographs of the new officers and biographical material appear elsewhere in this BULLETIN.

New Vice-President



F. E. Richart

Attendance

Many of the members are interested in the attendance figures of the meeting. The accompanying table gives registration data for several of the recent annual meetings from which it will be noted that 1949 was the second high, being exceeded only by the New York meeting of 1944 when there was a large number of visitors present. Attendance at the committee meetings was quite good, and there was a reasonably good attendance at most of the sessions, and at several the attendance was quite large.

REGISTRATION—ANNUAL MEETINGS

	Year	Members	Committee Members	Visitors	Total	Ladies
Atlantic City..........	1942	835	264	275	1374	219
New York............	1944	1185	368	510	2063	30 to 40
Buffalo...............	1946	978	405	452	1835	About 100
Atlantic City..........	1947	1071	469	246	1786	320
Detroit................	1948	1160	358	250	1768	133
Atlantic City..........	1949	1092	530	235	1857	335

Annual Dinner; Luncheon; Ladies' Entertainment

The Annual Dinner was an outstanding success. It was something of a departure from previous meetings. Sponsored by the Philadelphia District, there were no business functions or addresses, but a program of entertainment was provided following the excellent dinner. This entertainment was very well received. It consisted of four acts by high-class entertainers. The costs of the entertainment were underwritten through a special fund for this purpose raised by the Philadelphia District.

Another innovation at the meeting was to schedule an official session as a luncheon, and at this luncheon the annual address of the President (printed elsewhere in this BULLETIN) was presented, the first awards of 50-year certificates were given, and also the 40-year members were recognized. Past-President J. R. Townsend presented the Past-President Pin to retiring President R. L. Templin. Mr. Templin, in recognizing Mr. Townsend, commented on the latter's outstanding record of service as an officer of the Society which had occasioned a special letter of appreciation from the Board of Directors.

The luncheon also provided an opportunity for two representatives of the Pacific Committee on Arrangements to urge members to attend the Pacific Area Meeting, and particularly to return the transportation and hotel reservation forms which were a part of a special folder mailed to all members before the Annual Meeting. T. K. May, West Coast Lumberman's Assn., and P. V. Garin, Southern Pacific Co., spoke.

Executive Secretary Warwick gave brief citations for the 50-year members after which specially engrossed framed certificates were tendered by Mr. Templin. The 40-year members were also noted by Mr. Warwick and each received the 40-year certificate (see article elsewhere in this BULLETIN on 50- and 40-year members).

Many of the members commented favorably on the luncheon as an excellent way to schedule certain features of the meeting.

Ladies' Entertainment

The ladies' entertainment was planned under the auspices of the Philadelphia District with a hostess committee consisting of the wives of the Philadelphia Council. There was an informal tea with a palmist and music; a game night with bridge prizes and refreshments; a general tour of the interesting features of the hotel; and on Thursday afternoon Vice-President Markwardt showed his colored movies of an extensive sojourn through Holland and into Norway. There was much praise of the movies and the lecture.

Awards

This year the awards of the Charles B. Dudley Medal, the Richard L. Templin and the Sam Tour Awards were made on Tuesday night during the Edgar Marburg Lecture Session. The Sanford E. Thompson Award was made at the 18th Session on Thursday night. Biographical material on the winners of the awards and statement of the purpose of the award appear on a later page of this BULLETIN.

The Charles B. Dudley Medal was awarded to Messrs. W. W. Buechner, R. J. Van de Graaff, H. Feshbach, E. A. Burrill, A. Sperduto, and L. R. McIntosh for their paper on "An Investigation of Radiography in the Range from 0.5 to 2.5 Million Volts," published in the December, 1948, issue of the ASTM BULLETIN, page 54.

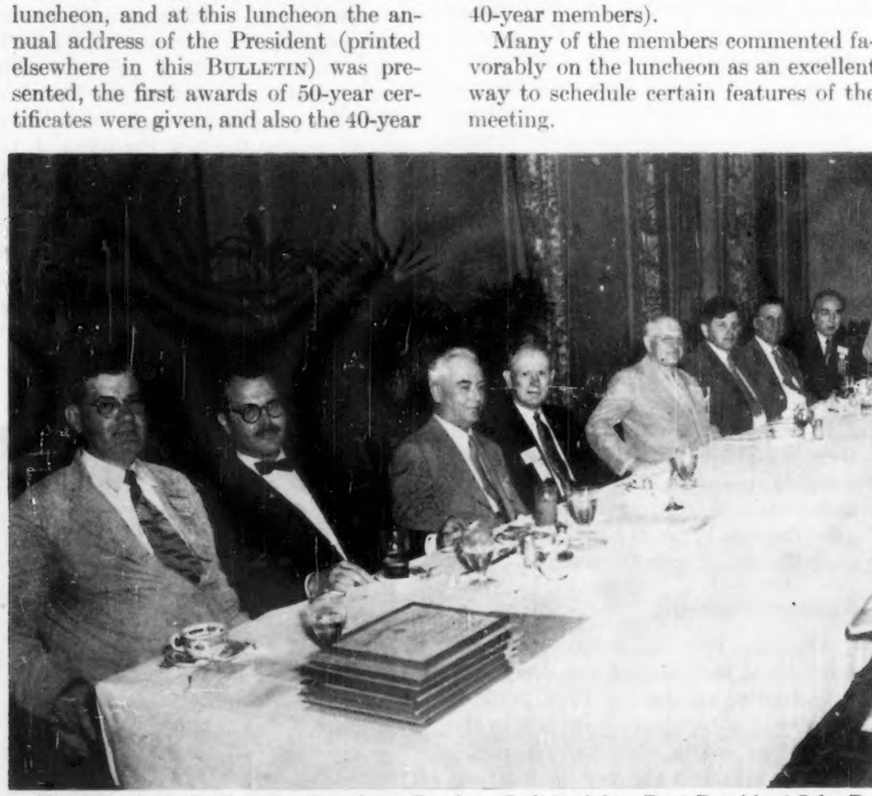
The Richard L. Templin Award was made to W. T. Lankford for his paper on "Hydraulic Bulge Testing of Sheet Metals," published in the Symposium on Deformation of Metals as Related to Forming and Service, STP No. 87.

The Sam Tour Award was made to Messrs. V. M. Darsey and W. R. Cavanagh for their paper on "Apparatus and Factors in Salt Fog Testing," published in the 1948 *Proceedings*, page 153.

The Sanford E. Thompson Award was made to Messrs. R. C. Mielenz and L. P. Witte for their paper on "Tests Used by the Bureau of Reclamation for Identifying Reactive Concrete Aggregates," published in the 1948 *Proceedings*, page 1071.

Appreciation to Philadelphia District

Arrangements for the dinner, ladies' entertainment, and other Annual Meeting functions were splendidly carried out by the A.S.T.M. Philadelphia District through its Council. Several meetings



Head Table at the Tuesday Luncheon Session: Left to right—Past-President John R. Townsend; Dr. W. M. Baldwin, Jr., 1949 Marburg Lecturer; President R. L. Templin; Past-President and Toastmaster T. A. Boyd; President-Elect J. G. Morrow; T. K. May, West Coast Lumbermen's Association—representing General Committee on Arrangements for Pacific Area Meeting; Senior Vice-President L. J. Markwardt; and Executive Secretary C. L. Warwick.

of the council and its executive committee were held, and there was an excellent spirit of cooperation and willingness to carry through. A. O. Schaefer, The Midvale Co., District Chairman, had the able assistance of District Vice-Chairman E. J. Albert, Thwing-Albert Instrument Co., who handled the dinner and cocktail party, and the other District Vice-Chairman, E. K. Spring, Henry Disston and Sons, Inc., concentrated on finances. Tinius Olsen 2d, Tinius Olsen Testing Machine Co., District Secretary, cooperated closely in all the activities, scheduling the meetings, preparing minutes and carrying out the numerous secretarial duties involved. The dinner entertainment was in the hands of L. Drew Betz of W. H. & L. D. Betz, and the ladies' entertainment was very ably handled by Howard S. Phelps, The Philadelphia Electric Co., who devoted a great deal of time to the work with the cooperation and guidance of a hostess committee. Special mention should be made of the help of Mrs. Phelps, Mrs. Spring, and others.

Pennsylvania Turnpike Diorama: On display all week was an interesting large diorama of the Pennsylvania Turnpike and its projected extension to Philadelphia; also a diorama of Valley Forge. The Commission and Haddon Hall cooperated, with the Society's approval, to arrange the display. It was studied by many of those at the meeting.

A Portion of the Over 300 Ladies Registered at the Meeting. This Group was just Beginning a Tour of the Haddon Hall Kitchens and Other Facilities

Notes on Some of the Sessions

Radiography

At the papers session on radiography sponsored by Committee E-7 on Non-Destructive Testing, seven papers on the latest developments in the field of radiography were presented as follows:

- X-ray Moving Pictures, C. M. Slack, Westinghouse Electric Corp.
- Recent Progress in High-Speed Flash Radiography, J. C. Clark, Los Alamos Scientific Laboratory.
- Initial Experience with the First Industrial Type Mobile Betatron, D. T. O'Connor, Naval Ordnance Laboratory.
- Mobilizing the Van de Graaff Generator for Precision Radiography, E. A. Burrill, High Voltage Engineering Corp.
- A Universal Exposure Calculator for Radium Radiography and Its Application to Current Industrial Radiographic Films and Techniques, N. A. Kahn, E. A. Imbembo, and Jay Bland, New York Naval Shipyard.
- Screen Penetrameters, H. H. Lester, Watertown Arsenal.
- Revised Procedure for Radiographic Standards, L. W. Ball and J. J. Pierce, Naval Ordnance Laboratory.

Interest in the session was evidenced by the attendance of approximately 180 people. During the presentation of Mr. Slack's paper by Donald Dickson, a five-minute film illustrated the purpose as well as the practicability of X-ray moving pictures.

It is expected to publish the papers in a special symposium volume in which will also be included the outstanding research paper which was awarded the 1949 Charles B. Dudley medal entitled, "An Investigation of Radiography in the Range from 0.5 to 2.5 Million Volts" by Messrs. W. W. Buechner, R. J. Van de Graaff, H. Feshbach, A. Sperduto, E. A. Burrill, and L. R. McIntosh.

Ultrasonic Testing

As a sequel to the round-table discussion on ultrasonic testing held in Detroit at the 1948 Annual Meeting, and which has since been issued in mimeograph form, Committee E-7 on Non-Destructive Testing held a papers session at the 1949 Annual Meeting on the theme, the practicability of ultrasonic testing as an aid to manufacturing processes as well as an inspection tool. Subjects covered were as follows:

- Basic Principles of Ultrasonic Testing, J. C. Smack, Sperry Products, Inc.
- Ultrasonics in the Testing of Tool Steels, J. C. Hartley, Barium Steel and Forge, Inc.
- Application of Ultrasonics to the Fabrication of Aluminum, J. V. Carroll, Aluminum Company of America.
- Ultrasonics in the Railroad Industry, E. D. Hall, Erie Railroad Co. (presented by S. E. Ladner).
- Ultrasonics in the Electrical Industry, D. M. Kelman, Westinghouse Electric Corp.

SUMMARY OF ACTIONS TAKEN AT ANNUAL MEETING AFFECTING STANDARDS AND TENTATIVES

	Existing Tentatives Adopted as Standard	Standards in Which Revisions Will be Adopted	New Tentatives	New Standards	Revision of Standard and Reversion to Tentative	Tentative Revisions of Standards	Existing Tentatives Revised	Standards and Tentatives Withdrawn	Present Total Standards Adopted	Present Total Tentatives
A. Ferrous Metals—Steel, Cast Iron, Wrought Iron, Alloys, etc.	5	8	0	4	17	0	8	1	133	82
B. Non-Ferrous Metals—Copper, Zinc, Lead Aluminum, Alloys, etc.	19	43	4	0	0	5	45	0	102	94
C. Cement Lime, Gypsum, Concrete and Clay Products	6	20	10	0	0	12	1	1	155	36
D. Paints, Petroleum Products, Bituminous Materials, Paper, Textiles, Plastics, Rubber, Soap, Water, etc.	63	51	63	0	6	8	47	15	560	329
E. Miscellaneous Subjects, Testing, etc.	3	3	0	0	0	0	3	0	42	35
Total	96	85	77	4	23	25	104	17	992	576

Application of Ultrasonics to Naval Problems, H. M. Trent, Naval Research Laboratory.
Application of Ultrasonics to Bronze Forgings and Ingots, A. Piltch, Naval Gun Factory.

There was an attendance of approximately 150 people at this session. Following the papers, the meeting was opened for discussion and several very informative talks were given. It is hoped that these papers may be published in a special book.

Fatigue of Metals

At this session, the first of the meeting, five papers were presented dealing with the subject of fatigue of metals. It is obvious that despite all the papers and publications on this phenomenon of fatigue, new facets and phases are discovered as research goes on. And the recognized importance of fatigue grows rather than diminishes as we move forward. This session was indicative of this situation.

The first paper on "The Influence of Fluctuations in Stress Amplitude on the Fatigue of Metals" was by T. J. Dolan of the University of Illinois and two of his associates. The authors reported on tests made on three steels and 75S-T aluminum alloy, with greatest emphasis on tests employing a loading cycle in which each 1000 cycles of a major stress amplitude were followed by 9000 cycles of a lower (minor) stress amplitude.

W. Lee Williams of the U. S. Naval Engineering Experiment Station presented interesting studies on "The Effects of Spray Metallizing Procedures on the Fatigue Properties of Steel." The four conventional methods of surface roughening, namely, electric bonding, grit blasting, rough threading and grooving and knurling were investigated and the data in the paper will be of extreme usefulness to many design engineers confronted with the problem of the reclamation of worn surfaces.

G. R. Gohn, Bell Telephone Laboratories, Inc., described an ingenious new high-speed sheet metal fatigue testing machine designed for unsymmetrical bending studies. M. J. Manjoine, Westinghouse Electric Corp., presented a paper on "Effect of Pulsating Loads on the Creep Characteristics of Aluminum Alloy 14S-T," the tests having been conducted at 400 F. The final paper by B. J. Lazan, Syracuse University, reported "Dynamic Creep and Rupture Properties of Temperature Resistant Materials Under Tensile Fatigue Loading." Among the alloys studied were N-155, S-816, Vitallium, and 19-9DL and data were reported for tests conducted at 1350 and 1500 F.

Identifying Metals Rapidly

An attendance of over 175 attested a strong interest in the Symposium on Rapid Methods for the Identification of Metals that was sponsored by Committee E-3 on Chemical Analysis of Metals. The symposium included discussions of the general principles of the various methods in current use and of specific applications of rapid identification methods to particular classes of metals and alloys.

Eleven papers were presented covering spot tests with color-forming reagents (including electro spot testing and electrography), spark tests, hardness (file) tests, test based on magnetic properties, and other rapid methods for identifying metals. Uses of these methods that were discussed ranged from rapid separation or sorting of metals to tests showing distribution patterns of materials and tests suitable for semi-quantitative analysis. The tests all had in common the factors of rapidity and of being essentially nondestructive.

Testing Cast Iron

Committee A-3 on Cast Iron sponsored a two-session Symposium on Testing Cast Iron with the SR-4 Type Gage with J. S. Vanick presiding at the morning session and Hyman Bornstein in the afternoon. Both sessions were well attended and produced very lively discussion.

The first group of three papers related to the measurement of stresses in cylinder blocks, with papers by M. A. Erickson, Chrysler Corp., R. J. King, Caterpillar Tractor Co., and S. J. Stockett and H. W. Lownie, Jr., Battelle Memorial Institute. The next two papers related to testing of miscellaneous engine parts and were by H. M. Hardy and T. O. Kuivinen, Cooper-Bessemer Corp., and C. L. Newton and J. D. Swannack, Fairbanks-Morse Co. The last two papers of the morning session gave some very interesting stress-strain tests on various cast-iron beam sections, the papers having been written by Oliver Smalley, Meehanite Metal Corp., and by H. M. Hardy and T. O. Kuivinen.

The first group of papers in the afternoon session described the stress analysis of valves and related items and included papers by V. T. Malcolm and Sidney Low, Chapman Valve Mfg. Co., E. C. Sears, J. W. Miner, and E. D. McCauley, American Cast Iron Pipe Co., Harold Wyatt, Lunkenheimer Co., and J. A. Cameron, Elliott Co. The remainder of the papers covered stress-strain studies of miscellaneous applications of cast iron. These were most interesting, including those by R. A. Flinn and R. J. Ely, American Brake Shoe Co., relating to cast iron for railroad service, and Hyman Bornstein, Deere and Co., on measurement of stresses in tractor castings. Other contributions were by Given A. Brewer, Massachusetts Air Industries, and V. E. Hillman, Compton & Knowles Loom Works.

Steel and Effect of Temperature

The title of the Tenth Session was not too indicative of the subjects included since there were reports on metallography, on malleable iron, corrosion of iron and steel, steel itself, and ferro-alloys. Statements on accomplishments of these committees appear later in this BULLETIN in the section devoted to committee accomplishments. Certain changes in the reports of Committees A-5 and A-7 are noted.

The session was marked by a special tribute to Committee A-1 on Steel on its

Western Members Promote Interest in Pacific Area Meeting

EVERY member and and visitor at the Annual Meeting should have been conscious of the fact that the Society is sponsoring a Pacific Area National Meeting in San Francisco the week of October 10. A special folder giving detailed information on the technical program, entertainment features, transportation, and hotel data was mailed to each member about two weeks before the Annual Meeting.

The General Committee on Arrangements wished to take advantage of the Annual Meeting to promote interest and attendance at the San Francisco Meeting. First of all, there was a good-size special banner on display near the registration desk reading "Come to San Francisco 1949." Also displayed was a specially designed large poster with appropriate views of western spots; and the Pacific Area delegation at the meeting wore miniature sombreros captioned "Come to San Francisco." In addition, T. K. May, West Coast Lumberman's Assn., member of the General Committee on Arrangements, and P. V. Garin, Southern Pacific Co., chairman of the Transportation Committee, spoke at the Society luncheon, closing with the theme "See you in San Francisco in October."

Fiftieth Anniversary, and a special note elsewhere in this BULLETIN refers to remarks by Executive Secretary Warwick and the resolution offered by President Templin.

There were six technical papers, each quite significant. C. W. Muhlenbruch, Northwestern Technological Institute, reported some unusual studies involving elastic and fracture toughness of type 301 stainless steel sheet and rod. He found that the elastic toughness of a steel with 180,000 psi. tensile was some 26 times that of S.A.E. 1020 steel, and about 9 times greater than an S.A.E. 2315 steel. Using actual tension impact data, the fracture toughness of an annealed stainless steel was roughly two and a half times that of the S.A.E. 1020 or 2315, and of the 24S-T aluminum as corrected for weight.

A tremendous amount of data was correlated and evaluated by Messrs. Freeman, Reynolds, Frey, and White in their paper covering the effect of heat treatment and hot-cold work on the N-155 alloy. This alloy is of the low-carbon type with considerable amounts of chromium, nickel, cobalt, molybdenum, and tungsten. They reported that for yield strength of room temperature (0.02 per cent offset) solution treatments gave 30,000 to 50,000 psi. Aging treatments increased the range from 38 to 53,000, and hot-cold work boosted the figure to 67 to 134,000 psi. Similar treatments affected the rupture strength at 1200 F. respectively, as follows: 35,000 to 40,500, 35,000 to 44,000, and for the hot-cold work 39,000 to 56,000 psi. The ranges indicate the necessity for better control processing for consistent and reproducible properties. Hot-working conditions can have a pronounced effect on properties even after solution treatments up to 2200 F.

Along somewhat related lines Messrs. Smith and Dulis, of the U. S. Steel Corp. Research Laboratory, described the effect of manufacturing practice on creep and creep-rupture strength of low-carbon steel. The data based on 12 heats show rather wide results influenced largely by the deoxidation practice. Depending on the refining and deoxidation processes, the estimated stress for rupture in 10,000 hr. ranged from 12,000 to 22,000 psi., and the observed stress to produce a minimum creep rate (the so-called second stage of the elongation-time curve) of 0.1 per cent per hour ranged from 19,000 to 32,000 psi.

Evaluation Tests for Stainless Steels

The Chairman of this Fifteenth Session, Dr. H. L. Maxwell, commented that the two sessions on stainless steel probably represented at least 2000 years of engineering experience, based on attendance and experience of those present.

The first of the ten papers presented in the two sessions gave an account of the "Present Knowledge of Low Carbon 18–8" and was ably presented by H. C. Cross in the absence of the author, H. W. Gillett.

Effects of various acid media and copper sulfate - sulfuric acid solutions on stainless steels were used as subjects of half of the papers.

Several papers dealt with the corrosion resistance of stainless steels containing various percentages of carbon, molybdenum, and columbium.

"Some Observations on Tests for Intergranular Susceptibility of 18–8 Mo Stainless Steels" pointed out that a large number of variables now exist and that a standard practice should be inaugurated. Particularly, it was shown that the cooling rate after stabilizing is important since it can effect sensitization of the alloy.

G. H. Comstock's "Results of Some Plant Corrosion Tests of Welded Stainless Steels" compared tests on Types 304, 321, and 347 sheets made in a number of chemical plants with the same steels tested in the laboratory by standard boiling nitric acid procedure.

Interest in the two sessions was evidenced by the discussers, the number of which was limited only by the time available.

Sessions on Bituminous Materials, Cement and Concrete, Soils, and Wood Poles

Three papers of special interest to those in the field of soil mechanics were presented at the first of four sessions covering soils and other building materials. Many participated in the discussion of these papers, which presented information on chemical and mineralogical tests, subsurface explorations by geophysical methods, and a study of mechanical oscillators.

A group of 13 papers included in a Symposium on Accelerated Durability Testing of Bituminous Materials occupied two sessions. These papers emphasized the complexity of bitumen as a material and the difficulty of taking it apart completely either physically or chemically to gain a better understanding of its structure and its behavior under various circumstances of use. The papers in each session were grouped generally according to those materials used for road purposes and those used for roofing and waterproofing, respectively. One of the many discussions presented was by Dr. A. R. Lee of the Road Research Laboratories of England.

Four papers presented as part of the 18th session contained interesting data and information on a variety of subjects pertaining to the field of concrete. A wetting-and-drying test for predicting cement aggregate reaction, chemical reactions of Indiana aggregate in disintegration of concrete and engineering properties of coral reef materials were followed with an interesting paper on concrete for airport runways by Inge Lyse, a well-known consulting member of Committee C-9 who is now connected with the Norway Institute of Technology. Dr. Lyse introduced a new departure in the suggested design of concrete slabs for airport runways recommending that the slab be poured in two layers, the top slab being generally four inches in thickness resting on a bottom slab.

A Round-Table Discussion was sponsored by Committee D-7 on Wood to present a proposed program for testing wood poles to determine allowable fiber stresses. This was attended by a very representative group of organizations directly interested, such as telephone and telegraph, public service and utilities, and wood treating companies, as well as such government agencies as the Bureau of Yards and Docks and Rural Electrification Administration. There was considerable discussion the results of which will be of material assistance to the committee in furthering this program, especially as to means of implementation.

The 22nd and final session of the meeting grouped three papers on the testing of cements and cement mixtures, with one paper on fire tests by Dr. H. S. Ingberg (retired), of the National Bureau of Standards, which referred to size and border conditions of test specimens in the relation to results of fire tests.

Water-Borne Industrial Wastes

ONE of the interesting features of the session in which was the Round-Table Discussion on Need for Standards for Examination of Water-Borne Industrial Wastes was the sound film in color by the Dow Chemical Co. entitled "Air, Water and Industry." This showed very clearly the problem that had confronted that company in handling the multitudinous variety of wastes resulting from the manufacturing operations of many chemicals and how the company had met its obligation to the community and state at large in treating the wastes before they were discharged into the Chippewa River. In a number of instances, the film showed how wastes had been converted into by-products of commercial value.

R. C. Adams and L. K. Herndon, the

(*Continued on p. 14*)

R. D. Bonney

N. L. Mochel

C. H. Fellows

H. F. Gonnerman

M. O. Withey

New Officers

THE RECENT election of officers, as announced at the Annual Meeting by the tellers, resulted in the unanimous election of J. G. Morrow as President (1949–1950), F. E. Richart as Vice-President (1949–1951), and the following as Directors (1949–1952): Robert D. Bonney, C. H. Fellows, H. F. Gonnerman, Norman L. Mochel, and M. O. Withey. Biographical material on these seven men follows:

President

J. G. MORROW, the new President, is Metallurgical Engineer, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada. Born in Hamilton, Mr. Morrow attended the Collegiate Institute, specializing in Chemistry. His work with the Steel Company began in 1905 as Chemist; later he was Inspecting Engineer, and has been Metallurgical Engineer for many years. A member of A.S.T.M. since 1911, he is affiliated with numerous other professional and technical organizations, including the following: The American Iron and Steel Institute, Society of Automotive Engineers, The American Wire Association, Association of Professional Engineers of Ontario, Canadian Institute of Mining and Metallurgy, and Canadian Industrial Preparedness Association (a Director).

During World War II, Mr. Morrow was Technical Adviser to the Canadian Steel Controller, and Chairman of Technical Advisory Committee on Alloy and Special Steels, Department of Munitions and Supply, Ottawa. He also served on the Administrative Committee, United States National Emergency Steel Specifications, War Production Board (representing Canada), and was on a number of its subcommittees. He was appointed Vice-President, Atlas Plant Extension Limited, a Crown Company incorporated to augment Canada's supply of alloy steel and gun forgings. One of his important positions is the chairmanship of the Canadian Standards Association in which he has been extremely active. He was the Canadian representative in the work of Unification of Screw Threads, which Accord was signed by the representatives of Great Britain, Canada, and the United States in November, 1948.

In A.S.T.M. he has been particularly concerned with the work of Committee A-1 on Steel where he serves on numerous subcommittees. He also represents his company on Committee B-1 on Wires for Electrical Conductors. Mr. Morrow is the first President of the Society from outside the United States. At the present time the Society has a large and active group of members in Canada.

His hobbies are yachting and fishing. He is a member of the Royal Canadian and the Royal Hamilton Yacht Clubs.

Vice-President

FRANK E. RICHART, the new Vice-President, is Research Professor of Engineering Materials, University of Illinois, Urbana, Ill. A native of Illinois, Professor Richart graduated from the University of Illinois in 1914 with the degree of B.S. in Civil Engineering, later receiving his M.S. and C.E. degrees. For a few years he held various engineering positions involving railway and public utility work, and for one year he was structural engineer with the Emergency Fleet Corporation. Beginning in 1916, he has been with the Department of Theoretical and Applied Mechanics at Illinois and since 1926 has been in charge of the concrete research laboratory and graduate teaching in concrete. He has been extremely active in this field and has prepared numerous reports and technical papers, and directed a great volume of research and testing work. A member of the Board of Direction, American Concrete Institute, he was President of this organization in 1939. In addition to the American Society for Testing Materials and American Concrete Institute, he is a member of the following organizations: American Society of Civil Engineers, Western Society of Engineers, Society for Experimental Stress Analysis and Highway Research Board.

In A.S.T.M. he has taken a very active part in the work of Committee C-9 on Concrete and Concrete Aggregates (is a past Chairman), Committee C-3 on Brick, and served on numerous administrative committees including the important Committee on Standards and the Committee on Papers and Publications. He is completing a term as a Director of the Society.

Among his numerous nonprofessional activities is a consistent interest in golf. He is a member of the Illinois Seniors' Golf Association, is on its Board of Governors, and is Past-President of the Urbana Golf and Country Club. Professor Richart has served as a member of the Intercollegiate (Big Ten) Athletic Conference for many years and is at present Chairman of this important body.

New Members of Board of Directors

ROBERT D. BONNEY, Assistant Manager of Manufacturing, Congoleum-Nairn, Inc., Kearny, N. J., following his studies in the public schools of Wakefield, Mass., where he was born, attended Massachusetts Institute of Technology, receiving his B.S. degree in Chemical Engineering in 1913. For two years he did graduate work and was instructor in Analytical Chemistry. Then followed three years as Chemist with Bird and Son, East Walpole, Mass. Since 1918 Mr. Bonney has been with his present company. For many years he was Chief Chemist in Philadelphia; later, beginning in 1928, he was Director of Research at Kearny. He has been Assistant Manager of Manufacturing since 1934.

In A.S.T.M. Mr. Bonney has rendered notable service on the Administrative Committee on Standards, of which he is at present Chairman. His other technical work has been concentrated especially in Committee D-1 on Paint, Varnish, Lacquer and Related Products, in Committee D-8 on Bituminous Waterproofing and Roofing Materials, and in Committee D-6 on Paper and Paper Products. A Past-President of both the Philadelphia and New York Paint and Varnish Production Clubs, he is a Council Member of the National Federation. His other professional affiliations include the American Chemical Society, National Farm Chemurgic Council and the American Institute of Chemists. Mr. Bonney's hobby is farming. He maintains a farm in Maryland and is a leading breeder of Aberdeen-Angus cattle.

C. H. FELLOWS, Head of Chemical Division, Research Department, The Detroit Edison Co., Detroit, Mich., was born in Kalamazoo, Mich., and matriculated at Purdue University where he studied Chemical Engineering, receiving his B.S. degree in Ch.E. Following service in the United States Army he entered the employ of The Detroit Edison Co. Research Department in 1919 and has headed the Chemical Division since 1925. He has been particularly concerned with water treatment and corrosion problems in steam generating plants and has prepared numerous papers and reports in these fields.

In the Society he has been especially active in the work of such committees as D-9 on Electrical Insulating Materials, D-19 on Industrial Water, D-2 on Petroleum Products and Lubricants, and Committee A-5 on Corrosion of Iron and Steel. He was formerly Chairman of the Joint Research Committee on Boiler Feedwater Studies. He has taken a very active in-

terest in the work of A.S.T.M. Districts, having served on the Detroit District Council for several years, and has completed a term as chairman of the Administrative Committee on District Activities.

Mr. Fellows' affiliations include the American Chemical Society, the National Association of Corrosion Engineers, and he is a member of the Edison Electric Institute, Power Station Chemistry Committee and serves on the City of Detroit Advisory Committee on Motor Fuels and Lubricants.

HARRISON F. GONNERMAN, Assistant to Vice-President for Research and Development, Portland Cement Association, Chicago, Ill., was born in Dixon, Ill. He attended the University of Illinois, receiving his B.S. degree in 1908, and M.S. in 1913. He served in the Engineering Experiment Station, University of Illinois, later was instructor in theoretical and applied mechanics, then from 1914 to 1920 was again active in the Experiment Station work. Then following two years in private business in California, Mr. Gonnerman was Associate Engineer, Structural Materials Research Laboratory, Lewis Institute, and Research Laboratory of Portland Cement Association. He was Director of Research of the latter and more recently Assistant to the Vice-President for Research and Development.

A Past-President of the American Concrete Institute, he has been very active in the work of this group. He is also affiliated with other engineering and technical bodies, including American Society of Civil Engineers, American Association for the Advancement of Science, Western Society of Engineers, and Highway Research Board.

An active member of A.S.T.M. Committee C-1 on Cement for over 20 years, he has served on many of its subgroups. He was formerly a member of Committee D-4 on Road and Paving Materials, Committee E-1 on Methods of Testing, and serves on various Sectional Committees of the American Standards Association. A prolific writer, Mr. Gonnerman has contributed papers and reports on such topics as cement, concrete materials, reinforced concrete, and methods of testing.

NORMAN L. MOCHEL, Manager of Metallurgical Engineering, Westinghouse Electric Corp., Philadelphia, Pa., was first employed in his home city, Pittsburgh, Pa., in the Inspection Department of the then Westinghouse Machine Co.; later was responsible for the work of testing of materials. During the first World War he served overseas in the Engineers Corps. For many years he has been in his present position as Manager of Metallurgical Engineering. An authority on the materials going into the turbine and other forms of power generation, he has rendered notable service to various branches of the Government including particularly the United States Navy and the National Advisory Committee on Aeronautics, and to various societies in which he is active.

While Mr. Mochel has served A.S.T.M. on many of its ferrous and non-ferrous committees, perhaps his most notable service is in Committee A-1 on Steel where he is at present serving his sixth term as its Chairman. Another notable record was his chairmanship for many years of the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals in which he is still active. Among other important A.S.T.M. work is his service on the A.S.T.M. Ordnance Advisory Committee. He has written many papers, his 1948 A.S.T.M. paper (with P. R. Toolin) on The High-Temperature Fatigue Strength of Several Gas Turbine Alloys, winning the A.S.T.M. Charles B. Dudley Medal for the outstanding paper on research.

Mr. Mochel is active in the work of many other organizations, including American Welding Society and American Society for Metals, and others.

M. O. WITHEY, Dean of the College of Engineering, University of Wisconsin, Madison, Wis., was born in Meriden, Conn. Professor Withey studied in the Thayer School of Civil Engineering, Dartmouth College, receiving his B.S. and C.E. degrees in 1904–1905. He soon became Instructor in Mechanics and Materials Testing Laboratory, University of Wisconsin; he was later Associate Professor of Mechanics in charge of the Materials Testing Laboratory. He became Professor of Mechanics in 1920 and headed the Department beginning in 1934. He has been Dean of the College of Engineering since 1946.

Professor Withey has specialized in studies of plain and reinforced concrete, but he has also carried out much research work in brick masonry, timber products, and structural steel. Some of the long-time tests on concrete which he undertook many years ago are still in progress. One of his important A.S.T.M. contributions was the work of the Research Committee on Yield Point of Structural Steel, of which he was the Chairman.

His A.S.T.M. technical affiliations include Committee C-9 on Concrete and Concrete Aggregates, Committee D-7 on Wood, and several committees dealing with testing; also the Committee on Mortars for Unit Masonry. He is a Past-President of the American Concrete Institute and was formerly President of the Wisconsin Society of Professional Engineers. His other memberships include the American Society of Civil Engineers, National Society of Professional Engineers, and the American Society of Engineering Education.

Professor Withey has written many reports and papers, and books. His hobby is golf.

MEDALISTS AND AWARD WINNERS

Charles B. Dudley Medal

This award is made for a paper of outstanding merit constituting an original contribution on research and engineering materials. It was established in 1926 as a means of stimulating research in materials and of recognizing meritorious contributions. It commemorates the name of the first President of the Society.

1949 DUDLEY MEDALISTS: MESSRS. W. W. BUECHNER, R. J. VAN DE GRAAFF, H. FESHBACH, E. A. BURRILL, A. SPERDUTO, AND L. R. MCINTOSH

W. W. BUECHNER, B.S. degree, M.I.T., 1935; Ph.D. 1939. On staff at M.I.T. since 1935, now Assistant Professor of Physics. Fellow, American Physical Society. R. J. VAN DE GRAAFF, M.S. degree, University of Alabama; Ph.D., Oxford 1928, Rhodes Scholar; National Research Fellow. On staff at M.I.T. since 1931, now Associate Professor of Physics. Fellow, American Physical Society. Awarded Medal of the Franklin Institute and Duddell Medal. H. FESHBACH, B.S. degree, College of City of New York, 1937; Ph.D., M.I.T., 1942. On staff at M.I.T. since 1941, now Associate Professor of Physics. Fellow, American Physical Society and Acoustical Society of America. E. A. BURRILL, B.S. degree, M.I.T., 1943. Staff member at M.I.T. 1941–1947. Now with High Voltage Engineering Corp., Cambridge, Mass. Member, American Physical Society and A.S.T.M. Committee E-7. A. SPERDUTO, B.S. degree, M.I.T., 1942. On staff at M.I.T. since 1941. Member, American Physical Society. L. R. MCINTOSH, degree in Electrical Construction at Wentworth Institute. On staff at M.I.T. 1941–1947. Now at High Voltage Engineering Corp., Cambridge, Mass.

W. W. Buechner R. J. Van de Graaff H. Feshbach E. A. Burrill Anthony Sperduto L. R. McIntosh

Richard L. Templin Award

The purpose of the award is to stimulate research in the development of testing methods and apparatus, to encourage the presentation to the Society of papers describing new and useful testing procedures and apparatus, and to recognize meritorious efforts of this kind.

1949 AWARD TO W. T. LANKFORD

MR. LANKFORD, a native of Tennessee, is Research Associate, Research and Technology Dept., Carnegie-Illinois Steel Corp. He received his B.S. degree in Metallurgical Engineering from Carnegie Institute of Technology in 1941 and his D.Sc. degree in 1945. Following a short period with Dow Chemical Co. he was Research Metallurgist at Carnegie Tech, later at Pennsylvania State College, and has been with his present company since November, 1945. An author of several papers dealing primarily with plastic flow and ductility of metals, he is the member of numerous technical societies including A.S.T.M., A.S.M., A.I.M.E., A.S.M.E., and S.E.S.A.

The Templin Award Winner—W. T. Lankford—Flanked on his right by the Award Committee Chairman, R. E. Peterson, and on his left by the Award Donor and 1948–1949 A.S.T.M. President R. L. Templin.

Sam Tour Award

The purpose of the award is to encourage research on the improvement and evaluation of corrosion testing methods and to stimulate the preparation of technical papers in this field.

1949 AWARD TO V. M. DARSEY AND W. R. CAVANAGH

V. M. DARSEY, President of Parker Rust Proof Co. since 1944, received his B.S. degree from Adrian College in 1927. Since graduation he has been continuously empolyed by Parker Rust Proof, starting as Plant Chemist, later holding the positions of Service Manager, Director of Research and Technical Director, before being made President. He has contributed several technical publications on corrosion prevention, and is author of patents covering materials and processes widely used in corrosion prevention. In addition to A.S.T.M. he is a member of A.C.S., S.A.E., and a Director of the Engineering Society of Detroit. Mr. Darsey has been very active in A.S.T.M., serving on several of its technical committees, and is an immediate past Chairman of the Detroit District Council.

W. R. CAVANAGH received his B.S. degree from Adrian College in 1937 and since then has been with Parker Rust Proof Co. He is currently Chemist in the Research Department, in charge of the Development Section. Member of A.C.S., he also is affiliated with Electrochemical Society, N.A.C.E., and Engineering Society of Detroit.

Sanford E. Thompson Award

The purpose of the award is to recognize a paper of outstanding merit on concrete and concrete aggregates presented at an annual meeting of the Society. It is sponsored by Committee C-9 on Concrete and Concrete Aggregates and is named in honor of the first Chairman of the Committee.

1949 AWARD TO R. C. MIELENZ AND L. P. WITTE

R. C. MIELENZ, a native of California, attended schools in San Francisco, Marin Junior College at Kentfield, and later the University of California at Berkeley. He received his B.S. degree in 1937 (Phi Beta Kappa) and his Ph.D. degree in 1940. He majored in geological sciences. He was employed by various oil companies, and in 1941 became petrologist in the Bureau of Reclamation, Denver, and has been Head of the Petrographic Laboratory for several years. He serves on A.S.T.M. Committee D-18 on Soils for Engineering Purposes. In addition to A.S.T.M. he is affiliated with several other organizations, including American Concrete Institute which in 1948 awarded him (with K. T. Greene and E. J. Benton) its Wason Medal.

L. P. WITTE, who received the award in Atlantic City on behalf of himself and Mr. Mielenz, is a native of Nebraska, where he attended the Lincoln Schools. Majoring

The Thompson Award Winners—Messrs. L. P. Witte, left, and R. C. Mielenz.

The First Sam Tour Award Winners—V. M. Darsey (second from left) and W. R. Cavanagh (extreme right). C. D. Hocker, Chairman of the Award Committee, and R. L. Templin, 1948–1949 President, A.S.T.M. Complete the Picture.

in geology, he graduated from University of Wyoming in 1934. He was on the All-Conference basketball team four years and during his last two years of college was on different All-American selections. Except for a two-year period, he has been with the Bureau of Reclamation in Denver. He has concentrated on concrete aggregates and design of mixtures for field structures. Currently he heads the Durability Unit of the Materials Laboratories. This Unit has a great deal of work under way involving freezing and thawing, and chemical reactions in related and associated tests. Mr. Witte is a member of A.S.T.M. and A.C.I.

50-Year and 40-Year Members

One of the interesting events at the Annual Meeting Luncheon was the recognition for the first time of individuals and companies that have been connected with the Society continuously for 50 years. At the same time the practice of recognizing 40-year members was continued.

Specially designed 50-year membership certificates, appropriately framed, were given to the representatives of the 50-year companies who were at the meeting, and the framed certificates will be mailed to the individuals, none of whom could be at the meeting. A facsimile of the 50-year membership certificate appears in this Bulletin.

The 40-year membership certificates were also awarded. The number of these that have been granted since the practice was established now totals 158.

There follows a list of the 50-year and of the 40-year members recognized at the 1949 meeting.

50-Year Members

American Foundrymen's Society (1898)
Bethlehem Steel Co., Inc. (1898)
Booth, Garrett & Blair (1898)
Carnegie-Illinois Steel Co. (1898)
Allan W. Dow (1898)
Robert W. Hunt Co. (1899)
Franklin Institute (1898)
William K. Hatt (1898)
The Lowe Brothers Co. (1899)
William Mueser (1898)

40-Year Members

Bird and Son, Inc.
George W. Borton
Everett W. Boughton
Joseph Brobston
Commonwealth Edison Co.
Electrical Testing Laboratories, Inc.
W. H. Fulweiler
General Electric Co., River Works
Heppenstall Co.
The Midvale Co.
Phelps Dodge Copper Products Corp., American Copper Products Division
Raymond Concrete Pile Co.
Schenectady Varnish Co., Inc.
The Sherwin-Williams Co.
Herbert Spencer
Tulane University of Louisiana
Isaac Van Trump
Western Electric Co., Inc., Hawthorne Works
Westinghouse Air Brake Co.
Alfred H. White

Representatives of Some of the Fifty-Year Company Members: From l. to r., L. J. Rohl, Carnegie-Illinois Steel Corp.; H. H. Morgan, Robert W. Hunt Co.; Henry Butler Allen, Franklin Institute; Paul J. Byler, Booth, Garrett & Blair; L. H. Winkler, Bethlehem Steel Co., Inc.; and Edgar W. Fasig, The Lowe Brothers Co.

Forty-Year Members and Representatives of Companies in this Class: Front Row, l. to r., Gordon Thompson, Electrical Testing Laboratories, Inc.; M. Van Loo, The Sherwin-Williams Co.; Everett W. Boughton; E. N. Downing, General Electric Co., River Works; A. O. Schaefer, The Midvale Co.; W. H. Fulweiler; Joseph Brobston. Second Row, l. to r., W. K. Aites, Westinghouse Air Brake Co.; Stanley H. Sallie, Bird and Son, Inc.; J. A. Succop, Heppenstall Co.; R. H. Thielking, Schenectady Varnish Co., Inc.; Alfred H. White; and H. A. Anderson, Western Electric Co., Inc., Hawthorne Works.

Steel Committee Complimented on Its 50th Anniversary

At the Session of the Annual Meeting at which the 1949 report of Committee A-1 on Steel was presented, there was special recognition of the fact that Committee A-1 on Steel had held its first meeting, and been organized, just 50 years ago. Prior to the A-1 Report, the Session Chairman, President-elect J. G. Morrow, an active member of Committee A-1, recognized Executive-Secretary Warwick, who presented some interesting notes on the committee's activities. Following this, President Richard L. Templin, offered the resolution shown below which was unanimously approved by the members at the session.

Mr. Warwick, who was the secretary of the committee from 1913 to 1920, and has followed its activities closely since, noted that the first meeting of the then Committee No. 1 of the American Branch of the International Association for Testing Materials, was held at the Franklin Institute on March 9, 1899. During the next year, the committee personnel was expanded, and as of May, 1900, there were 34 members. Now the committee has a voting list of upward of 300, with over 400 men active.

During the first year, the committee held seven meetings with several two-day sessions, and on April 10, 1900, ten specifications were submitted to letter ballot. They were approved by the Society in October, 1900, at its annual meeting, at which there were 30 people present. Mr. Warwick mentioned that he could go on almost indefinitely but said:

"I could begin to mention the many men, literally I am sure into the tens of dozens, who have contributed to the magnificent record of this committee over the years. One could tell many interesting things about the history of the 150 specifications which this committee has written over the years and for which it is now responsible to the Society. Instead, I shall close these brief remarks by observing that while proof of the value of the committee's work is not required in A.S.T.M. circles, such proof is all around us in the overwhelming acceptance that has been accorded to A.S.T.M. steel specifications throughout the producing and consuming industries of the country—and I might add throughout the world. I am sure the committee and the Society expect no finer recognition of these past 50 years of work than the knowledge that the testing and specifying of steel have been immeasurably advanced by the labors of the committee and the many men who have worked for and with it throughout those years."

The resolution, unanimously adopted at the meeting on motion by President Templin, reads as follows:

RESOLUTION

The members of the American Society for Testing Materials, assembled in annual meeting and noting that Committee A-1 on Steel is completing fifty years of continuous existence and is presenting its fiftieth annual report to the Society, sincerely commend the committee, its officers, and members for outstanding accomplishments in the development of standard specifications and tests for steel and steel products; and express their appreciation of the devotion of the committee to the many arduous tasks that have confronted it down through the years. The committee has well and ably served the interests of the Society and of the many industries producing and using this important material so basic to the economy of the nation. A grateful Society and the members thereof salute its oldest committee and extend wishes for continued success and accomplishment in the years that lie ahead.

Henry B. Oatley Elected A-1 Honorary Member

During the Steel Committee meetings, the Advisory Committee unanimously elected Henry B. Oatley, Vice-President, Combustion Engineering-Superheater, Inc., to honorary membership. Active in the committee for a great many years, Mr. Oatley is consumer Vice-Chairman of the main committee, and is also Vice-Chairman of the Subcommittee on Steel Tubing and Pipe. In the opinion of the Advisory Committee, Mr. Oatley has "rendered distinguished service to the committee." For years he has contributed a great deal to the administrative and technical affairs of the committee and as Chairman of the A.S.M.E. Boiler Code Committee and in other ways he has been able to implement the work which the steel committee does.

Mr. Oatley will continue his active work in Committee A-1 and in the various Subcommittees.

Annual Meeting Session Notes

(Concluded from page 9)

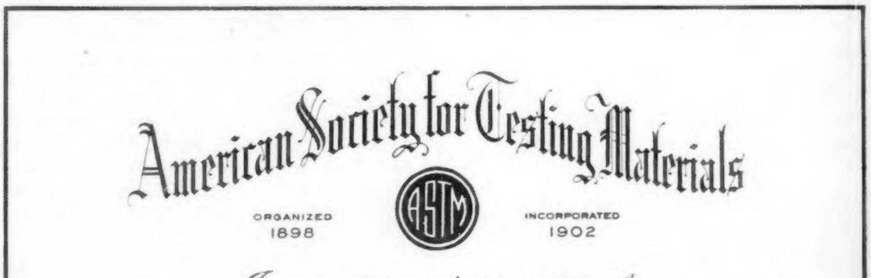
latter a vice-chairman of Committee D-19, presided as co-chairmen of the meeting and Mr. Herndon opened the discussion with a presentation of the needs of standards for inspection of water-borne industrial waste. This was followed by a discussion of the gaging and sampling by C. F. Hauck of Hall Laboratories, Inc., while a paper on the analysis of water-borne industrial wastes by G. D. Beal and S. A. Braley of the Marine Institute was presented by the latter.

Plastics

In addition to the presentation of the Report of Committee D-20 on Plastics, the activities of which committee are covered elsewhere, the session on Thursday devoted to Plastics consisted of the presentation of seven papers dealing with various tests that apply to plastics or presenting results of tests that have been carried out on specific types of plastics. The papers are as follows:

- Impact Testing of Plastics—Elimination of the Toss Factor, Bryce Maxwell and L. F. Rahm, Princeton University.
- Flexure Testing of Plastic Materials, J. W. Westwater, University of Illinois. (Formerly with University of Delaware.)
- Damping and Resonant Load-Carrying Capacities of Polystyrene and Other High Polymers, J. A. Sauer and W. J. Oliphant, Pennsylvania State College.
- The Creep Characteristics of Compression Molded Polyethylene, G. R. Gohn, J. D. Cummings, and W. C. Ellis, Bell Telephone Laboratories, Inc.
- Five Plastic Laminates Under Fatigue, Creep, and Static Loads, William N. Findley and W. J. Worley, University of Illinois.
- The Effect of Temperature on the Creep and Recovery of a Glass Fabric Laminate Molded with a Melamine Resin, William J. Worley and W. N. Findley, University of Illinois.
- Creep-Time Relations for Polysytrene Under Tension, Bending, and Torsion, J. Marin and G. E. Cuff, Pennsylvania State College.

Fortunately, most of the papers had been preprinted for with seven papers in addition to the report, the sessions would otherwise have been too crowded and would have permitted no opportunity for discussion.



Facsimile of Fifty-Year Certificate, the first awards of which were made this year. The seal, the words "Fifty Years," and the recipient's name are in gold, and the certificate was presented, framed.

The following notes are intended to give some idea of the major accomplishments and activities of the various technical Committees as reported at the Annual Meeting.

The notes are in order of the serial designation of the committees, "A" group first, "B," etc. Some of the "E" work is of direct interest to the other groups. News of Committees C-14, C-20, D-10, D-14, and the new Committee on Printing Ink follow at the end of these noter.

"A" Group

Committee A-1 on Steel

Numerous recommendations effecting product specifications were presented to the Society by Committee A-1 on Steel in its 1949 Annual Report, the fiftieth to be given by this group.

Standard Specifications A 59 for Silicon-Manganese Steel Bars for Springs, A 60 for Chromium-Vanadium Steel Bars for Springs, and A 68 for Carbon-Steel Bars for Springs, with Silicon Requirements, were extensively revised to bring them into complete conformity with present standard manufacturing compositions and practice. Standard Specifications A 14 for Carbon Steel Bars for Springs were recommended to be discontinued since this material is no longer supplied, having been replaced by Standard Specifications A 68.

The committee recommended revisions in the marking clauses of Specifications A 201, A 203, A 204, A 212, and A 225 for plates for boilers and other pressure vessels while reverting these specifications to a tentative status. In these revisions, the marking clauses are further clarified for the benefit of both producers and consumers. A match marking requirement has been added and the maximum dimension requiring only one marking was extended from the present 48 in. up to 72 in.

Standard Specifications A 109 for Cold Rolled Carbon-Steel Strip was reverted to a tentative status and extensively revised. Five tempers (classified according to Rockwell hardness ranges), six types of edges and three types of finishes are included. The tables of permissible variations and dimensions have been brought into conformance with present manufacturing practice.

Eight specifications covering rails joint bars, and track spikes, bolts and nuts were revised. These include Standard Specifications A 1, A 2, A 3, A 4, A 65, A 66, A 76, A 183 which are being reverted to a tentative status along with the recommended revisions.

Committee A-3 on Cast Iron

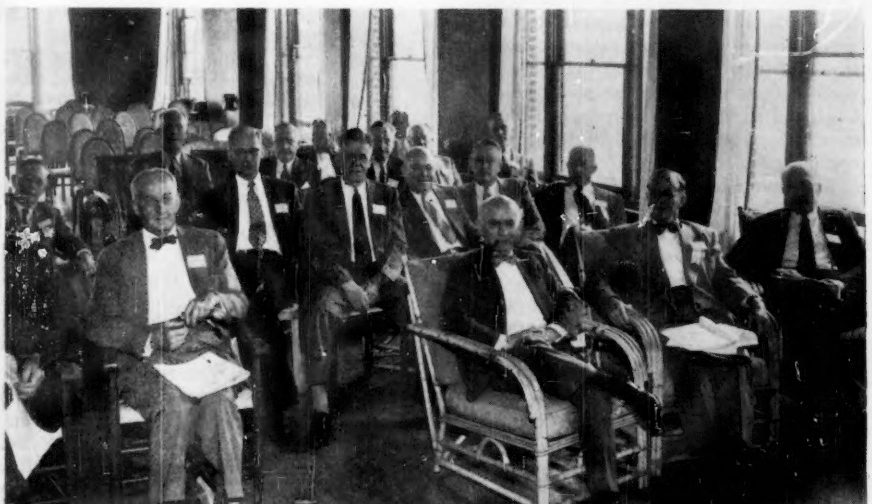
Committee A-3 noted with regret during the Annual Meeting the recent passing of its chairman, E. R. Young. Mr. Young had been associated with the work of the committee for many years and had served as secretary prior to his election last year as chairman. To fill the vacancy thus created, Vice-Chairman J. S. Vanick was elected chairman, Secretary C. O. Burgess was elected Vice-chairman, and H. W. Stuart of the United States Pipe and Foundry Co. was elected secretary.

The committee, as noted elsewhere, sponsored the Annual Meeting Symposium on The Testing of Cast Iron with SR-4 Strain Gages. The committee recommended important changes in the Standard Specifications for Automotive Gray Iron Castings (A 159–47) and their reversion to tentative. The changes related to the addition of chemical, physical, and structural requirements for brake drums and clutch plates. The Standard Specifications for Gray Iron Castings (A 48–48) was also editorially changed to add a chart showing the approximate Brinell hardness - strength relationship for cast iron. J. T. MacKenzie, former chairman of the committee, presented a detailed report on impact testing of the cast iron, which is proposed for an appendix to the report of the committee as published in the *Proceedings*.

During the meeting Subcommittee XIX on Chilled and White Iron Castings was reactivated with G. L. Richter of the Farrel-Birmingham Co., Chairman.

List and Designations of New Tentatives

A complete list of the new tentative specifications and tests and some of the more extensively revised tentatives, including the complete serial designations, appears on page 27. Members may wish to refer to this list when they review the statements on some of the highlights of the technical committee activities. In this accompanying text material no serial designations for the new tentatives are given, and in some cases the titles are shortened. Consult the list on page 27 for complete titles and serial designations of new tentatives.



A Portion of the A-1 Advisory Group of Committee A-1 on Steel. Front Row, beginning left: C. T. Edgerton, L. H. Winkler, H. H. Morgan, H. B. Oatley. Second Row, W. M. Barr, Committee Secretary H. C. Larson, Chairman N. L. Mochel, C. E. Loos, E. V. Bennett, J. J. Laudig. Third Row: C. A. Kelting, E. F. Lundeen, W. Warner, R. W. Steigerwalt, M. V. Healey. Way Back: Messrs. R. J. Painter and J. W. Caum. Readers can take the Associate Editor's word that off to the left, out of range of the camera, is the new A.S.T.M. President J. G. Morrow, and other Advisory Members.

Committee A-5 on Corrosion of Iron and Steel

Committee A-5 recommended that two tentatives be adopted as standard: Test for Weight and Composition of Coating on Long Terne Sheets by the Triple Spot Test (A 309 - 47 T) and Specifications for Zinc Coating (Hot Dip) on Iron and Steel Hardware (A 153 - 47 T).

The committee withdrew one of its recommendations effecting a revision in the Test for Uniformity of Coating by the Preece Test (A 239). These changes effecting Section 8*a*, the end point, and Section 10, were not fully agreed on in the committee, and will be studied further.

Subcommittee XV on Field Tests of Wire and Wire Products has appended to the report of Committee A-5 this year the extensive tabular data giving the results of the atmospheric corrosion tests on wire and wire products through 1948.

Committee A-6 on Magnetic Properties

Committee A-6 reported the completion of an important task—the extensive revision of the Standard Methods of Testing

Survey of Current Standardization Projects in September Bulletin

The extensive survey of current standardization projects under way in technical committees, which article has heretofore appeared in the August issue of the BULLETIN *will this year be included in the September number. The shift to eight* BULLETINS *yearly which provides for July and September issues and no August number necessitates this procedure. It was not possible to get from all of the technical committees the statements on which this survey is based in time to prepare it for this issue.*

This survey achieves several purposes. It acquaints the Society officers, the various administrative committees, and the Staff with the standardization work that is under way, and it informs the respective committee officers with work under way in other groups, and thus tends to avoid overlap. Perhaps of paramount importance the published summaries afford members a "look ahead" on the specifications and tests which are being developed in the large number of committees.

Magnetic Materials (A 34 – 48), consisting mainly of a regrouping under the general designation A 34, using the serial numbers A 340 to A 349 to designate the various sections. Methods A 34 – 48 comprised a voluminous document including 85 sections and 15 figures in a total of 36 pages. A minor revision in the methods, such as adding a new section, resulted in a large number of changes in internal references, etc. To eliminate this, the present sections in Methods A 34 have been regrouped under five designations: namely, A 34, A 341, A 342, A 343, and A 344. The present Standard Definitions of Terms with Symbols, Relating to Magnetic Testing (A 127 – 48) was redesignated A 340 and the present Tentative Specifications for Flat-Rolled Electrical Steel (A 310 – 47 T) adopted as standard with the new designation A 345.

It should be noted that the revision and regrouping of Method A 34 will in no way affect current reference to these methods as may now obtain on drawings or otherwise, for the new A 34 will, wherever A 34 is cited, still specify the use of the same methods that have now been regrouped under other designations.

Committees A-7 on Malleable Iron Castings and A-9 on Ferro-Alloys

While Committee A-7 had intended to recommend to the Society for adoption this year the Tentative Specifications for Pearlitic Malleable Iron Castings (A 220–48 T) and for Malleable Iron Flanges, Pipe Fittings and Valve Parts (A 277–44 T), it developed that there was not a consensus on this recommendation in the committee and both specifications were continued as tentative, pending further review.

Committee A-9 reported that it had completed the preparation of new specifications for ferrotitanium and for ferroboron, as well as an extensive revision of the Standard Specifications for Molybdenum Salts and Compounds (A 146–39). This work was not finished in time for submission to the Society at the Annual Meeting but is now completed and these three specifications will be immediately submitted to the Administrative Committee on Standards, with A 146 being reverted to tentative.

The committee also took stock of its present activities and has under consideration a proposed revision of its scope which will add to its responsibilities the preparation of specifications for alloying materials other than "ferro-alloys" used in mass melting operations in the steel and associated industries.

Committee A-10 on Iron-Chromium-Nickel and Related Alloys

This committee recommended revisions of the following tentative specifications: Corrosion Resistant Iron-Chromium and Iron-Chromium-Nickel Alloy Castings for General Application (A 296), and Heat-Resistant Iron-Chromium and Iron-Chromium-Nickel Alloys for General Application (A 297). These revisions were worked out in cooperation with the Alloy Casting Institute—to bring about a reconciliation between A.S.T.M. and A.C.I. compositions.

Subcommittee IV on Methods of Corrosion Testing organized during the year a Symposium on Evaluation Tests for Stainless Steels which was presented in two sessions at the Annual Meeting. This symposium presented a critical appraisal of the tests commonly used for the evaluation of the corrosion resistance of stainless steels with particular regard to their relation to practical experience with these alloys in environments different from those of the tests, and the manner in which these relationships are influenced by steel composition, especially very low-carbon content. At the meeting of this subcommittee held in March it was decided to proceed with a comprehensive program of atmospheric corrosion tests that have been under discussion for some years. The immediate step will be to secure the thousands of test specimens and prepare them for exposure.

"B" Group

Committee B-1 on Wires for Electrical Conductors

Committee B-1 reported to the Society the completion of an active year of work, recommending the adoption as standard of revisions in its three trolley wire specifications, B 9, B 47, and B 116; the adoption of four tentative specifications and one tentative method; revisions in six standards for immediate adoption and revision of four other tentative specifications.

During the meeting, Subcommittee V completed the preparation of new tentative specifications, except for minor details, for the steel wire used for reinforcement of A.C.S.R. cable and it was also voted to include these new requirements in the specification for this cable (B 232).

Committee B-2 on Non-Ferrous Metals and Alloys

Committee B-2 recommended to the Society for immediate adoption revisions in two standards: In the Specifications for Slab Zinc (Spelter) (B 6–48) a new note is added to cover the requirements for special high-grade zinc when used for the manufacture of zinc-base die-casting alloy ingot; the Specifications for Pig Lead (B 29–43) were amended to incorporate new sampling procedures worked out in cooperation with Committee E-3 on Chemical Analysis of Metals.

The committee recommended the adoption as standard of the Tentative Specifications for Babbitt Metal (B 23), Soft Solder (B 32), and Fire-Refined Copper for Wrought Products and Alloys (B 216). The committee also reported the acceptance earlier in the year by the Administrative Committee on Standards of a new Tentative Specification for Metallic Antimony (B 237–49 T).

The committee is actively engaged in a revision of a number of its nickel and nickel-alloy specifications.

Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys

Committee B-3 recommended that the Tentative Method of Salt Spray (Fog) Testing (B 117–44 T) be revised and a complete revision was appended to the report. The committee also recommended that the methods for total immersion (B 185) and alternate immersion (B 192) corrosion testing be continued as tentative without revision. Subcommittee VIII on Galvanic and Electrolytic Corrosion reported that the aluminum specimens have now been assembled and that all the specimens in the first part of their new program should be on exposure sometime this summer. Subcommittee VII on Weather reported the results of a number of tests with the object of comparing the corrosivities of the atmospheres of the different test sites with respect to iron and zinc. The complete report prepared by O. B. Ellis was appended to the committee's report under the title "Effect of Weather on the Initial Corrosion Rate of Sheet Zinc."

Committee B-4 on Electrical Heating and Related Alloys

Committee B-4, while it did not meet during the Annual Meeting, reported the completion of a very active year of work with a new Tentative Recommended Practice for Cathode Melt Prove-In Testing (B 238–49 T) and a new Tentative Specification for a Circular Cross-Section Nickel Cathode Sleeve for Electronic Devices (B 239–49 T) recently accepted by the Administrative Committee on Standards. The committee recommended advancement to standard of three test methods: for Resistivity (B 63), for Life Test of Contact Materials (B 182), and for Diameter of Fine Wire by Weighing (B 205).

Much progress has been made on all phases of the work, particularly in the Cathode Section of Subcommittee VIII, which has for the past few years been studying intensively the emissivity of cathode nickel. The two new tentatives mentioned above originated in this section and it is currently working with Committee E-3 on Chemical Analysis of Metals on methods of analysis for cathode nickel.

Committee B-5 on Copper and Copper Alloys

This committee reported the completion of work on revision of many specifications. These recommendations included revisions in 25 tentatives and in 35 standards for immediate adoption, tentative revisions in 5 standards, the adoption of one tentative as standard and of 5 tentative revisions as standard, as well as a completely rewritten and revised Recommended Practice for Tension Test Specimens for Copper-Base Alloys for Sand Castings (B 208).

Some idea of the extent of the revisions recommended by Committee B-5 in its specifications can be obtained by reviewing the nature of what these changes were. In 43 specifications revisions were made to incorporate provisions for sampling as worked out in conjunction with Committee E-3; in 60 specifications a new section was added on the significance of numeric limits, referencing E 29; in 27 specifications there were adjustments in chemical limits; in 25, revised alloy designations; in 28, revised dimensional tolerances; in 9, insertion of cross-reference to the types of copper given in Classification B 224; in 11, new requirements for elongation in four times the diameter instead of in 2 in. were added; and in 6, requirements for bend testing were deleted.

Committees B-6 on Die-Cast Metals and Alloys and B-7 on Light Metals and Alloys

Committee B-6 recommended the new Specifications for Zinc-Base Alloys in Ingot Form for Die-Castings. These were prepared because of a need for an ingot specification which could be used specifically by the smaller die-casting companies to purchase ingot to make die-castings to conform to the Specifications for Zinc-Base Alloy Die-Castings (B 86–48). Committee B-6 has been working on this problem for more than a year.

The committee reported that its Subcommittee on Exposure and Corrosion Tests has completed plans for recalling and testing zinc and magnesium alloy test bars from 9 exposure locations after 10 years of exposure and aging. Twenty-one companies represented on the committee have volunteered their services to conduct the mechanical property tests on these specimens.

Committee B-7 on Light Metals and Alloys recommended for publication as tentative a new proposed Specification for Aluminum Alloy Pipe, also revision in 12 tentative specifications and the adoption as standard of the Tentative Specifications for Aluminum in Iron and Steel Manufacture (B 37–46 T).

The Special Subcommittee on Atmospheric Exposure Testing has completed its plans for a new series of tests that have been worked out in cooperation with Committee B-3, and collection of samples for this research program will be made during the coming year.

Committees B-8 on Electrodeposited Metallic Coatings and B-9 on Metal Powders

Committee B-8 presented for publication a new Tentative Recommended Practice for the Preparation of High-Carbon Steel for Electroplating. Further recommendations were that the Tentative Specifications for Electrodeposited Coatings of Zinc on Steel (A 164) and of Cadmium on Steel (A 165), and Chromate Finishes on Electrodeposited Zinc, Hot-Dipped Galvanized, and Zinc Die-Cast Surfaces (B. 201) be revised and continued as tentative. The committee also recommended that the following two tentatives be approved for adoption of standard without revision: Recommended Practices for Chromium Plating on Steel for Engineering Use (B 177–45 T) and for Preparation of Low-Carbon Steel for Electroplating (B 183–43 T).

Appended to Committee B-8's report was the report of Subcommittee II on exposure tests of copper-nickel-chromium deposits on high-carbon steel and electrodeposited lead coatings on steel. Subcommittee V on Supplementary Treatments for Metallic Coatings, in addition to the five sections actively engaged in studying various phases of chromate and phosphate coatings on zinc and cadmium, has organized a sixth section to study and suggest testing methods for the evaluation of supplementary organic finishes on electrodeposited metallic surfaces.

Committee B-9 on Metal Powders and Metal Powder Products submitted the new tentative Definitions of Terms Used in Powder Metallurgy. The compilation of this glossary of terms has been a major task of the committee and has taken a great deal of thought and work. In its preparation advantage was taken of suggestions from Committee E-8 on Nomenclature and Definitions. This set of definitions now published by A.S.T.M. is the first compilation of terms used in this important industry and will fill a long-felt need.

"C" Group

Committee C-1 on Cement

Several recommendations were presented by Committee C-1 on Cement including four new tentatives, two being a method for determining sodium oxide and potassium oxide in portland cement by flame photometery and for measuring the setting time of hydraulic cement. Two new specifications covering the ten-inch flow table and natural cement complete this group. The new specification for natural cement is in effect a revision of the existing A.S.T.M. Standard C-10 which it will replace when adopted.

A tentative revision of Standard Specifications for Portland Cement (C 150) will provide a limit on the air entraining properties of normal portland cements to be less than 15 per cent for all types. A further revision of C 150 for immediate adoption will delete the present limitations on aluminum oxide and ferric oxide for Type V Cement adding a footnote covering limitations on tricalcium aluminate and tetracalcium aluminoferrite. An additional revision for immediate adoption in the autoclave expansion test method C 151 suggests changes in the apparatus which will provide a more suitable pressure gage and at the same time stress the importance of observing safety precautions.

To provide for two types of masonry cement, for general purposes and where high strength is required, a revision was recommended for immediate adoption in the Standard Specifications for Masonry Cement (C 91). A general revision, for immediate adoption, was made calling for the omission of certain of the lowest graduation lines on glass graduates used in the various cement testing methods. For the purpose of keeping in general accord the Federal and A.S.T.M. standards for laboratory atmospheric conditions the committee has recommended that in all cement test methods the temperature requirement will be 23 ± 1.7 C.

Committee C-7 on Lime

Committee C-7 acted to recommend the advancement to standard of three tentative specifications for lime, namely, Normal Finishing Hydrated Lime (C 6 T), Special Finishing Hydrated Lime (C 206 T), and Hydrated Lime for Masonry Purposes (C 207 T). The Tentative Methods of Physical Testing of Quicklime and Hydrated Lime (C 110 T) was also recommended for advancement to standard. At its meeting the committee accepted a definition of the term "agricultural liming material" subject to letter ballot. Two new specifications will be submitted to the committee after review by the proper sub-

committee, covering chemical lime as used in grease and calcium carbide manufacture, respectively.

Committee C-9 on Concrete and Concrete Aggregates

Five new tentative methods of test were presented by Committee C-9 culminating a year of extensive studies by the subcommittees concerned with specifications and test methods. These new methods should be of considerable interest to the industry inasmuch as they provide a means of measuring properties heretofore not covered but of vital concern. Four methods pertain to concrete providing means of measuring bleeding; air content of freshly mixed concrete by the pressure method; air entraining admixtures; and comparing concretes on the basis of the bond developed with reinforcing steel. The fifth new tentative, jointly under the jurisdiction of Committees C-9 and D-4, provides a method of testing for soft particles in aggregates on the basis of scratch hardness.

A revision in four standards was recommended for adoption covering the requirements and procedure for capping concrete specimens as applicable to C 31, C 42, C 78, and C 116. Revisions for adoption were also presented including a refinement in the measurement and controls in the testing of molded concrete cylinders (C 39) and for measuring the length of drilled concrete cores (C 174). This also includes revision of the Standard Specifications for Concrete Aggregates (C 33) to bring it into conformity with the Simplified Practice Recommendation R 163–48. A revised definition of the term "mineral aggregate" is to replace the tentative definition as found in C 58 T.

Committee C-15 on Manufactured Masonry Units

This active committee recommended tentative revisions of seven standards including the Standard Specifications for Building Brick (C 62) which adds a waiver of durability requirements where no frost action occurs or precipitation is less than 20 in. New sections are added to Standard Methods of Sampling and Testing Brick (C 67) covering methods for measurement of size and warpage. The individual minimum compressive strength for grade NA sewer brick (C 32) was recommended for change from 2000 psi. to 2200 psi. as well as the maximum percentages of water absorption by 5-hr. boiling from 20 to 22 for average and from 24 to 25 for individual brick.

At the meeting recommendations were passed covering revisions in the table on absorption in specifications for structural clay nonload-bearing tile (C 56) and for structural clay floor tile (C 57). A recommendation was passed changing the classification of "heavy duty" to "special duty" in the Specifications for Structural Clay Facing Tile (C 212 T), with the addition of a paragraph on plaster base finish.

Committee C-17 on Asbestos-Cement Products

Initial specifications covering asbestos-cement products, four in number, were submitted to the Administrative Committee on Standards just previous to the Annual Meeting by Committee C-17 on Asbestos-Cement Products. These four specifications cover asbestos-cement roofing shingles, siding shingles, flat sheets, and corrugated sheets, respectively. Methods of test are included in the specifications. At its meeting the committee approved the addition of significance of tests statements for the above specifications. A method of test on asbestos-cement pressure pipe was approved for incorporation into a specification on this material. It is the decision of the committee that it will not take fasteners and accessories under consideration, such items not being considered as part of the material itself.

"D" Group

Committee D-1 on Paint, Varnish, Lacquer, etc.

Committee D-1 on Paint, Varnish, Lacquer, and Related Products and 66 of its subcommittees and sections held meetings over a three-day period. At the conclusion of the main D-1 meeting the following three papers were presented:

Direct Reading Attachment for Stormer Viscosimeter, by John H. Calbeck, American Zinc Sales Co., Columbus, Ohio.

A Method for the Standardization of Krebs Modified Stormer Viscometers, by C. F. Jackson and W. H. Madson, E. I. du Pont de Nemours & Co., Wilmington, Del.

Correlation of Accelerated Weathering Machines, by Roy W. Hill, George Cook, and William E. Moyer, under the direction of Arthur W. Van Heuckeroth, Engineer Research & Development Labs., U. S. Army, Fort Belvoir, Va.

Cooperation with the Federation of Paint and Varnish Production Clubs has resulted in the approval by the Federation of 20 additional A.S.T.M. specifications and methods of test. This brings the total to 30 A.S.T.M. standards approved by the Federation.

Committee D-1 withdrew from its report as preprinted the proposed tentative method of test for heptane number of hydrocarbon solvents and test for determination of kauri-butanol number of hydrocarbon solvents. These will be given further study. There were included in the report as preprinted three new tentatives accepted recently by the Society through the standards committee. These covered specifications for secondary butyl alcohol (D 1007 – 49 T), method for measurement of dry film thickness of paint, varnish, lacquer, and related products, and method for conducting exterior exposure tests of paints on wood.

The subject of bituminous emulsion has been under study in the committee for some time and this resulted in the presentation of new tentative methods of testing bituminous emulsions for use as protective coatings for metal.

The report also presented five other new tentative methods on the following subjects: Acetone number of drying oils, night visibility of traffic paints, aniline point of hydrocarbon solvents, total nitrogen in resins, and exterior exposure tests of paints on steel. An extensive revision of the test for 60-deg. specular gloss of paint finishes (D 523 – 49 T) was also accepted. The Subcommittee on Drying Oils is conducting cooperative work on hydroxyl number, break test and diene value.

Additional work on traffic paints includes study of accelerated tests for durability, accelerated tests for suspension, and a study of glass beads for traffic paints. The Subcommittee on Volatile Solvents has in preparation a method of test for naphtha tolerance and is also studying methods for diluting power of hydrocarbon solvents. The Subcommittee on Chemical Analysis presented revisions in the methods of analysis of zinc dust, white pigments, iron oxide pigments and chrome pigments. It is studying methods of analysis of blue pigments and is studying certain general methods for pigments such as water-soluble matter. The Subcommittee on Varnish reported considerable progress on methods of test for drying time. Other tests under study cover nonvolatile content, dust-free time, flexibility, viscosity of transparent liquids, chemical resistance of dry varnish films, and test for evaluating the exterior durability of varnish. The Subcommittee on Optical Properties reported work on a new method of test for gloss evaluation of high gloss finishes. A Subcommittee on Resins is conducting cooperative work on precipitation methods for the determination of total solids, melting-point methods, acid number of alkyd resins, iodine value of extracted fatty acids, solvent tolerance of amino resins, iodination method for the estimation of pure phenols, quantitative determination of chlorine and polyvinyls. Surveys are in progress on resin solubility, haze measurements, specific gravity, clarity and color of solid resins, classification and identification of phenol resins by heat, quantitative isolation and estimation of free phenols in phenolic resins, and volumetric determination of chlorine in vinyl resins.

The new Subcommittee on Electrometric Testing of Films has undertaken study of a method for conducting time-potential tests. This work will be followed by study of the measurement and the significance of changes in the electrical resistance of paint films. The Subcommittee on Physical Properties reported the following subjects in its program of work: measuring the consistency of paste, hardness of paint films, chalk resistance of pigments, oil absorption and specific gravity of pigments and adhesion and permeability of paint films.

The Subcommittee on Cellulose and

Related Products recommended publication as tentative of the new distillation method for solvents and diluents.

A paper on Surface Preparation and Repainting of Structural Iron and Steel, was presented by Arnold J. Eickhoff.

The organization meeting of the new Subcommittee on Printing Ink was held under its chairman, Paul J. Thoma, of *Time-Life* Publications. There is considerable interest in this project as was evidenced from the excellent attendance and the nature of the discussion and questions raised by those present. Brief informational reports were made on the following subjects:

Definitions
Methods Review
Fineness of Grind
Drying Time
Rubproofness
Tack Measurement

There was discussion on the scope of work to be undertaken by the committee including raw materials, printing ink, and application of the ink to paper in various types of printing. The next meeting of this subcommittee will be held in Atlantic City in November, see page 26.

Committee D-2 on Petroleum Products and Lubricants

Committee D-2 on Petroleum Products and Lubricants had the distinction again this year of presenting to the Society the largest report both as to size (146 pages) and number of recommendations on standards. These included six proposed methods published as information, 12 new tentative methods of test, revisions of 8 tentatives, adoption as standard of 6 tentatives, revisions of 10 standards, and withdrawal of 1 standard and 1 tentative. Meetings of this committee and its numerous subcommittees totalled 65 and extended over the full five days of the Annual Meeting. The actions taken at these meetings will require the presentation to the Society of a supplementary report containing a number of additional recommendations.

Committee D-2 will hold its fall meeting in San Francisco the week of October 10, at which time it will also sponsor two symposium sessions. The meetings are expected to cover three days. The midwinter meeting of the committee is scheduled for Washington, D. C., at the Shoreham Hotel, February 20 to 24, 1950.

At its Annual Dinner on Tuesday evening, Committee D-2 honored Harry M. Hancock, Atlantic Refining Co., for the many contributions he has made to the work of the committee.

One of the highlights of the D-2 meetings was an informal Symposium on Exhaust Valve Burning held in connection with the meeting of Technical Committee B on Lubricating Oils.

One of the most active projects has been the comprehensive A.S.T.M. Manual on Measuring and Sampling Petroleum and Its Products. The first section of this new Manual, which it is expected will be completed by the end of the year, will contain complete methods for sampling, gaging, temperature measurement, and calculating liquid quantities of petroleum and petroleum products. Later sections of the manual will cover methods for tank calibration and extensive tables for oil measurement, volume correction, etc. These oil measurement tables are of international interest and are being developed in cooperation with the Institute of Petroleum (British). At the meeting, L. C. Burroughs, chairman of the division responsible for these tables, who had just returned from Europe, presented an extensive report of a meeting in Brussels attended by representatives from 16 countries. Agreement was reached on some 37 tables which when completed it is estimated will comprise about 1100 pages. Decision has been made as to the basic data and methods of calculation, formulas, and scope of the numerous tables. It is anticipated that the actual calculation work will be undertaken this summer.

An important revision in the Specifications for Gasoline (D 439 – 38 T) is under consideratfon, which would raise the maximum vapor pressure from "13.5 lb." to "15.0 lb." for certain sections of the country at different seasons of the year. Technical Committee A on Gasoline is actively studying methods for measurement of the sludge, varnish, and gum forming tendency of fuels. A method for determining existent gum and oxygen stability in Diesel fuels and light fuel oils is also under study.

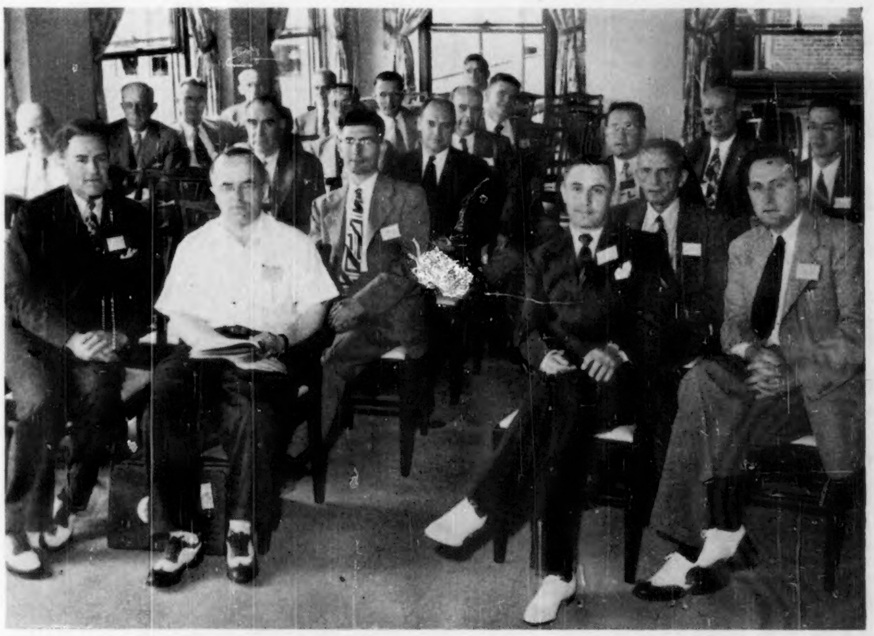
Technical Committee B on Lubricating Oils announced plans for its Symposium on

H. M. Hancock

Honor Guest at D-2 Dinner

High-Additive Content Oils to be held at the San Francisco meeting in October. The subject of motor oil classifications is currently commanding considerable attention and there was further review of the matter at the meeting. Other subjects under study in this technical committee include instrument oils, and lubricants for compressed air tools.

Technical Committee C on Turbine Oils will sponsor a Symposium on the Lubrication of Turbine Equipment at the October, San Francisco meeting. The scope of this technical committee has been enlarged to include lubrication of non-aircraft gas turbines. Its active projects include a recommended practice for the cleaning of turbine lubricating systems and studies of tests for rusting, oxidation, emulsion, and oil film strength characteristics.



Meeting of Division II on Measurement and Sampling of Committee D-2 on Petroleum Products and Lubricants. Front Row, l. to r., L. C. Burroughs, Jack Sherman, B. J. Heinrich, Edward Phillips. Extreme Left, I. E. Manning. Second Row, Robert Matteson, A. J. Kraemer. Third Row, A. E. Becker (over Mr. Sherman's head), J. H. Berglund, P. J. Smith, and a visitor. Others in the Photograph Include: J. G. Detwiler, H. C. Packard, L. S. Wrightsman, Paul L. DeVerter, Mark Gay, M. R. Lipkin, J. J. Moran, F. D. Tuemmler, and N. J. Gothard.

Technical Committee G on Lubricating Greases presented two new methods, one a microne cone penetration test and the other for apparent viscosity of lubricating greases. The first method fills the need for a consistency test for small size samples and the second provides a means for measuring flow properties of greases in engineering units. Work is to be undertaken on the development of methods for dynamic oxidation, thixotropy, determination of extreme pressure elements in lubricants, and for chemical corrosiveness of greases.

Technical Committee H on Light Hydrocarbons was responsible for three new methods of test for butadiene covering procedures for acetylene, oxygen, and peroxides. It also recommended as tentative three methods published as information last year covering procedures for separation of residue, butadiene dimer, and nonvolatile residue of butadiene. An important revision and improvements in the Reid vapor pressure method were also completed. A new method of test for pentanes in butadiene just completed will be included as information in the supplementary report of the committee.

Technical Committee K on Cutting Fluids has under way cooperative studies on the laboratory evaluation of cutting liquids and is also carrying on studies on the plant evaluation of cutting fluids. Extensive preliminary tests on tool life tests on lathes are to be run by cooperating laboratories on some seven fluids to evaluate the method for reproducibility. Studies are also being undertaken on emulsion stability tests, and rust preventive tests of soluble oils. This technical committee presented for publication as information definitions, nomenclature, and a classification of cutting fluids.

The Research Division on Combustion Characteristics has continued its activity in the improvement of the knock testing methods. A 1949 Appendix will be issued to the A.S.T.M. Manual of Engine Test Methods of Rating Fuels. This new appendix will include information on the special carburetor jacket permitted for rating fuels which would be subject to vapor lock under normal operating conditions. It will also include a minor revision in the specifications for reference fuels, and up-to-date information on engine and part number changes. The 1949 Appendix will include also the material from the 1948 Appendix. The division announced plans for a series of meetings in San Francisco including a symposium session covering its numerous activities and investigations.

The Subcommittee on Determination of Inorganic Elements in Lubricants plans to sponsor a symposium at the October, San Francisco meeting which will discuss polarographic methods for metal analysis and related subjects. This subcommittee is actively studying procedures for determination of sulfur, chlorine, phosphorus, and lead in lubricating greases in cooperation with Technical Committee G. A method for determining phosphorus is expected to be ready for publication later in the year.

The Subcommittee on Analysis of Petroleum Products for Hydrocarbon Types has been continuing its extensive work on Method D 940 which will be divided this year into two separate methods: test for measurement of freezing points for evaluation of purity, and test for determination of purity from freezing points. A new method of test for hydrogen in petroleum fractions by the lamp method was presented as tentative. Two methods published as information last year were submitted as tentative. These covered, respectively, tests for total olefins plus aromatic hydrocarbons and tests for benzene and toluene by ultraviolet spectrophotometry. Two new procedures for determination of bromine number were presented for inclusion in the supplementary report. These cover a colorimetric method and an electrometric procedure.

Meeting of Division III on Elemental Analysis of Committee D-2 on Petroleum Products and Lubricants. Second from the left in the front row is Louis Lykken of Shell Development Co., Chairman of the Division. The other men in the Photograph are members of the Division or visitors at the meeting.

Committee D-3 on Gaseous Fuels

In Committee D-3 action was taken to submit to letter ballot two new proposed tentative methods. The first will provide procedures for the measurement of gaseous fuel samples; the second covers the specific gravity of gaseous fuels, including liquefied petroleum gases, in gaseous state at normal temperatures and pressures. The apparatus covered by the specific gravity methods is sufficiently varied so that one or more of the methods specified may be employed for laboratory, control, reference, or in fact for any purpose where it is desired to know the relative density of a gas or gases as compared to the density of dry air at the same temperature and pressure. The direct weighing method is specified for reference test purposes and for calibration; field conditions, however, call for a more practical method. Consequently two commercially available balances (one recording) have been selected and their methods of operation explained in sufficient detail to permit the observer to make measurements readily and accurately, provided the instructions outlined in the method are properly followed.

The committee has in preparation methods of sampling manufactured gas and procedures for sampling natural gas. It is also cooperating with Committee D-2 on methods for sampling liquefied petroleum gases. The Subcommittee on Water Vapor Content of Gaseous Fuels, decided at its meeting to submit the dew point method to letter ballot review. The Subcommittee on Complete Analysis of Chemical Composition of Gaseous Fuels is completing its study of methods for analysis by the mass spectrometer and by volumetric chemical methods. It is hoped that these two methods may be completed within the coming year for submission as tentative.

Committee D-4 on Road and Paving Materials

Committee D-4 at its meeting accepted a recommendation for a new Tentative Method of Test for Soft Particles in Coarse Aggregate currently being recommended by Committee C-9. The committee presented numerous recommendations. Another joint recommendation with Committee C-9 calls for the withdrawal of a tentative revision to Standard Method of Test for Abrasion of Coarse Aggregate by Use of the Los Angeles Machine (C 131), submitted in 1947, replacing it with a new tentative revision which in addition to broadening the scope of the test in order to provide for sizes up to 3 in. also will make the same conditions apply to coarser sizes as now exist with the present four gradings. Revisions of five existing tentatives are recommended changing size requirements and adding further refinements. These include Methods of Sampling Bituminous Materials (D 140T), Specifications for

Hot-mixed, Hot-laid Asphaltic Concrete for Base and Surface Courses (D 947), Specifications for Asphaltic Mixtures for Sheet Asphalt Pavements (D 978), Methods of Sampling Bituminous Paving Mixtures (D 979), and Specifications for Bituminous Paving Plant Requirements (D 995). Extensive revisions for immediate adoption affect the Float Test for Bituminous Materials (D 139) and standard sizes were changed in four specifications for coarse aggregate (D 448, D 692, D 693, and D 694) in order to conform to the latest revision in the Simplified Practice Recommendation R 163–48. A proposed method for compression test of compacted bituminous mixtures was approved by letter ballot. Another proposed method, closely allied to the compression test, was accepted for letter ballot, covering immersion-compression test of compacted mixtures.

Committee D-5 on Coal and Coke

With its report Committee D-5 on Coal and Coke presented a revised standard method of drop shatter test for coal (D 440 – 49). A new Subcommittee on Ultimate Analysis methods is accumulating data and conducting experimental work with a view to revising the procedures for determining carbon, hydrogen, and nitrogen as given in standard methods D 271.

Work is being renewed on a study of a laboratory method for testing the reactivity or ignitibility of coal. Additional studies are to be undertaken on the plasticity and swelling of coal as soon as further standardization of the instrument design has been completed. Consideration is being given to a revision of the test for free-swelling index of coal (D 720) involving a scheme for designating coals which do not form a coherent mass. It is also planned to make provision for estimating swelling index of coals which do not give buttons that match the standard profiles.

Experimental work is continuing on the problem of collecting representative samples of pulverized coal from streams of coal and air inside pipes between coal pulverizers and furnaces. Procedures for making fineness tests in the laboratory are also under study. This work will lead to a major revision of the present standard method (D 197 – 30).

Committee D-6 on Paper and Paper Products

New tentatives recommended by Committee D-6 on Paper and Paper Products consisted of tests for creasing paper for permeability tests, fiber composition of paper and paperboard, ply separation of combined container board, and scuff resistance of paperboard. Revisions in the Standard Method of Conditioning Paperboard, Fiberboard and Paperboard Containers for Testing (D 641) were recommended for adoption adding a new paragraph dealing with the necessity for reconditioning of specimens preparatory to testing. Four tentative methods were recommended for advancement to standard without change. These cover Bleeding Resistance of Asphalted Paper at Elevated Temperature (D 917), Blocking Resistance of Paper and Paperboard (D 918), Copper Number of Paper and Paperboard (D 919), Crease Retention of Wrapping Paper (D 920), and Titanium Dioxide in Paper (D 921). New methods covering erasability, chlorides, sulfates, gloss, lint, pinholes, and expansivity of paper were reported as nearing completion. A new specification for analytical filter paper will be presented for approval as soon as certain revisions are made in the Tentative Methods of Testing Analytical Filter Papers (D 981T).

Committee D-7 on Wood

Culminating intensive activity on the part of several of the subcommittees of Committee D-7 on Wood, three new specifications, four new methods of test, and one new tentative set of definitions of terms were recommended for adoption. The specifications cover creosoted end grain wood block paving for interior use, chromated zinc chloride, and tanalith, the latter two being additional wood preservatives. The four methods include chemical analysis of chromated zinc chloride and of tanalith, conducting static tests of wood poles, and tests for evaluating the properties of building boards. A new set of definitions of terms relating to plywood and veneer completes this group.

Included for immediate adoption were extensive changes in the methods of testing small clear specimens of timber (D 143). These changes will be effective in developing future international agreement on methods of testing wood and are based on the recommendations of an international conference, but do not affect the basic procedures for the several mechanical tests.

The committee, at its meeting, accepted a complete new tentative, subject to letter ballot, to replace the present Standard Specifications for Structural Wood Joist and Planks, Beams and Stringers and Posts and Timbers (D 245). New specification will cover the broad principles of stress grading as set forth in U.S.D.A. Miscellaneous Publication No. 185.

Committee D-8 on Bituminous Waterproofing and Roofing Materials

Due to work being still incomplete Committee D-8 on Bituminous Waterproofing and Roofing Materials confined its recommendations to the advancement to standard of four tentatives and tentative revisions. The tentative specifications for Asphalt for Damping and Waterproofing (D 449T) and for Coal-Tar Pitch for Steep Build-Up Roofs (D 654T) were recommended without revision for advancement to standard. The Tentative Methods of Sampling Bituminous Materials (D 140T) was also recommended for advancement to standard, subject to a revision in the minimum weight of the gross sample, this change being also jointly recommended by Committee D-4. The fourth recommendation, concurrently recommended by Committee D-4, advances the tentative revision submitted in 1947 of the Standard Methods of Testing Emulsified Asphalts (D 244) to standard.

Committee D-9 on Electrical Insulating Materials

Committee D-9 and 20 of its subcommittees held meetings extending over 3 days. The committee presented a new tentative recommended practice for the purchase of uninhibited mineral oil for use in transformers and oil circuit breakers. This was prepared by Subcommittee IV on Insulating Oils which has been very active. One study has concerned the behavior of new and reclaimed transformer oils in actual transformer service. This study was started in 1945 and an endeavor has been made to collate laboratory tests with actual service life of the oil. The first exhaustive summary of the extensive data accumulated on this project was presented by F. M. Clark in a paper on "The Evaluation of Mineral Transformer Oil During Commercial Use." The paper was presented by E. A. Snyder since Mr. Clark was attending a meeting in Stresa, Italy, of the Advisory Committee on Insulating Oils, of the International Electrotechnical Commission, June 13 to 15.

New tentative methods of testing glass bonded mica were accepted. These methods cover tests required for investigation or examination of this material for use as electrical insulation. Another important new tentative was a recommended practice for maintaining constant humidity by means of aqueous solutions. This provides procedures suitable for obtaining constant relative humidities ranging from 30 to 98 per cent at temperatures from 0 to 70 C. in small airtight containers. This tentative was presented jointly with Committee D-20 on Plastics.

The Subcommittee on Insulating Papers has been especially active. It presented a new tentative method of test for aqueous extract conductivity of paper used in electrical insulation. It also reported completion of four additional new tentative methods to be presented to the Standards Committee during the Summer. These cover alcohol-soluble matter of paper, water-soluble matter, water-soluble sulfates of paper and paperboard and specifications for absorbent laminating paper for electrical use. Work is being undertaken on companion specifications covering untreated electrical insulating paper and following this specifications for condenser tissue will be prepared.

The revised tentative methods of test for electrical resistance of insulating materials represent the culmination of several years' study by the Subcommittee on Electrical Test. Work is now to be undertaken on a similar extensive review and revision of the methods of test for power factor and dielectric constant of electrical insulating materials (D 150 – 47 T).

The Subcommittee on Mica Products announced that the color transparency reference standards for the visual classi-

fication of natural Muscovite block mica were now being made available. These mica transparency standards which were described in the ASTM May BULLETIN consist of a set of negatives for each of the 10 classifications of mica. Each color transparency illustrates the maximum, nominal and minimum imperfections allowed for each grade. On orders received up to July 25, the price is $150 per set of the 10 color transparencies. Orders should be sent to A.S.T.M. Headquarters. To provide detailed instructions for use of the color transparencies, the committee has completed an extensive review of the methods of testing, grading, and classifying natural mica (D 351). The revised methods will be presented as tentative to the Standards Committee during the summer and will be issued at the same time that the reference standard transparencies are available.

The Subcommittee on Molded Materials reported extensive activity. A test for stress of plastic tubing has been completed and a new test for oven aging is under study. Specifications for electrical grades of thin cellulose acetate sheets are in preparation. Another section is starting work on specifications for electrical grades of urea and melamine molding materials. This committee is cooperating with the Armed Services and with the National Electrical Manufacturers Association in revising the specifications for laminated materials.

Committee D-11 on Rubber and Rubber-Like Materials

Committee D-11 and its subcommittees held a total of some twenty meetings over a period of three days. Committee D-11 has been participating in the activities of Technical Committee 45 on Rubber of the International Organization for Standardization. The committee decided to extend an invitation to I.S.O. Committee 45 to hold its 1950 Meeting in the United States at Cleveland, in October, 1950, at which time Committee D-11 plans to hold a series of meetings.

Work is to be undertaken on crude rubber which work will be coordinated with that of other groups interested in such standards.

The committee will submit to the Society as tentative the proposed specifications and methods of test for concentrated, ammonia preserved, creamed and centrifuged natural rubber latex. These specifications are of international interest and in their present proposed form have been distributed to interested parties in a number of countries that produce rubber latex.

The Subcommittee on Thread Rubber reviewed the first draft of several procedures for testing this material. After changes the methods are to be submitted to a number of interested manufacturers and others for further study.

There were four new tentative specifications accepted covering rubber protective equipment for electrical workers. These covered line hose, insulator hoods, blankets, and sleeves. In the sleeves specifications a note is to be added pointing out that the 10,000-v. test voltage limitation is due to the testing procedure and not to the inherent nature of the material. It was reported that the Specifications for Electrical Gloves (D 120 – 40) are under extensive revision and will require a year before completion. The four specifications have also been approved for reference to the American Standards Association for approval as American Standard.

An important accomplishment of Committee D-11 this year was the revised specifications for latex foam rubbers and for sponge and expanded cellular rubber products. Some further changes are to be made in these specifications as the result of suggestions from the SAE-ASTM Technical Committees on Automotive Rubber. These revised specifications classify the material on a product basis and are very timely in view of extensive use or this material in automotive and other applications.

The Subcommittee on Packings submitted for publication as tentative the navy seal aging test. The Subcommittee on Physical Testing of Rubber Products presented an extensive revision of the Standard Methods of Tension Testing of Vulcanized Rubber (D 412 – 41). The revised methods are to be issued as tentative and will be submitted to the Standards Committee during the summer. The Subcommittee on Processibility Tests recommended the shearing disk viscometer method for publication as tentative.

Committee D-13 on Textile Materials

Committee D-13 on Textile Materials again presented to the Society a very extensive report. It was announced that its next meeting was scheduled for October 19 to 21 in Philadelphia, Pa., at the Benjamin Franklin Hotel. This next meeting will be featured by a Papers Session on the subject of microscopy as applied to textile fibers and their products.

Two recommendations were withdrawn from the report of Committee D-13 as preprinted. These covered proposals for the adoption as standard of the Tentative Methods of Test for Fineness of Wool (D 419 – 47 T) and Specifications and Methods of Test for Fineness of Wool Tops (D 472 – 47 T).

One of the most important methods presented this year by Committee D-13 covered procedures for core sampling of wool in packages for determination of percentage of hard scoured wool content which may be found applicable to other materials. This subject was discussed at length in the paper on "Some Problems in the Sampling of Bulk Materials," by Louis Tanner, Customs Laboratory, and W. Edwards Deming, Bureau of the Budget.

A new tentative method of test for stretch of hosiery represented the first accomplishment of the new subcommittee on this subject. Other new tentatives included methods for testing single kraft yarn, specifications and tests for asbestos lap, and tests for yarn number of yarn from fabrics.

An important revision in the Tentative General Methods of Testing Cotton Fibers (D 414 – 47 T) comprised the addition of an alternate method for determining length of cotton fibers by means of the Fibergraph or optical method. The new method describes completely the apparatus and its operation and includes directions and illustrations for measuring the fibrogram and reporting the results. Important changes were made in the test methods for cotton yarns, and for glass yarns, and in the test for resistance of textile fabrics and yarns to insect pests.

Committee D-15 on Engine Antifreezes

This relatively new committee presented an informative report covering its studies of various projects under way. The next meeting of this committee will be held in New York City at the Hotel Statler, September 22 and 23, 1949.

The committee is completing a method for determining the freezing point of antifreeze solutions based on extensive cooperative tests of three proposed methods. It has completed a specification for a hydrometer-thermometer antifreeze field tester. Publication of this specification is being deferred until the method for determining freezing point is available.

Studies are under way on methods for determining distillation and specific gravity of antifreezes. Further work is in progress on the boiling point of mixed antifreezes and the specific gravity of aqueous antifreeze solutions.

A series of cooperative tests is under way on the following chemical properties of antifreeze materials and their aqueous solutions: pH and reserve alkalinity, water content, ash, and solids on evaporation.

A circulating corrosion test method based on the procedure used by the National Bureau of Standards is the subject of cooperative laboratory tests. When these studies are completed the committee plans to submit the method to the Society for publication.

A new Subcommittee on Specifications has been established and has suggested that the following properties are of first importance both in the development of test methods and as a basis for specifications: freezing point, boiling point, field testing, pH and reserve alkalinity, corrosion, foaming, storage stability, and solids on evaporation.

Committee D-16 on Industrial Aromatic Hydrocarbons

Committee D-16 plans to submit to a letter ballot vote of its membership a plan of enlarged scope and a change in name of the committee to cover aromatic chemicals. If favorable the proposal will go to the Board of Directors of the Society.

Of the 21 specifications and methods for which Committee D-16 is responsible there are only two tentatives, namely, Test for Thiophene in Benzene (D 931 –

47 T) and Test for Specific Gravity of Industrial Aromatic Hydrocarbons (D 891 – 46 T). The committee proposes to recommend to the Society in 1950 the adoption of Method D 931. It believes that further simplification of Method D 891 is desirable and this will be studied.

Committee D-17 on Naval Stores

Committee D-17 reviewed in detail the various methods included in its report as preprinted. The committee submitted to the Society five new methods for testing rosin covering procedures for the following: ash, iron, unsaponifiable matter, acid number, and saponification number.

The committee has in preparation a complete set of methods for testing rosin oils based on methods proposed by V. E. Grotlisch.

Committee D-19 on Industrial Water

The most important action reported by Committee D-19 was the formation and activation of a new Subcommittee on Water-Borne Industrial Wastes, with a scope which "comprises the preparation of standard methods for sampling of waterborne industrial wastes, the preservation and analysis of samples, and the methods of reporting the results of such analyses." The chairman of this subcommittee is L. Drew Betz. The Nineteenth Session at the Meeting was a round-table discussion of this subject.

The committee recommended as tentative four new methods: sampling steam; acidity and alkalinity; suspended and dissolved solids; and determination of iron in industrial water. Six tentatives were recommended for adoption as standard. These dealt with sampling industrial water (D 510), embrittlement testing (D 807), N.D.H.A. corrosion test (D 935), sampling of water-formed deposits (D 887), reporting analysis of such deposits (D 933), and for manganese content of water (D 858). Revisions of the standards for chloride ion (D 512), for sulfate ion (D 516), and for reporting results of analysis (D 596) were also recommended for immediate adoption.

Committee D-20 on Plastics

Committee D-20 has been actively cooperating with other committees on materials of overlapping interest. On plasticizers and resins it is cooperating with Committee D-1, on the aging of vinyl materials with Committees D-1 and D-11, and on vulcanized fibers with Committees D-9 and D-6.

The Subcommittee on Nomenclature and Definitions reported that it had appointed a new section on pictorial representation to collect photographs illustrating various types of flaws and imperfections in plastics as an aid to descriptive nomenclature.

The Subcommittee on Permanence Properties is undertaking work on the effect of gases on plastics. This will include also permeability and gas transmission.

With its report the committee included two tentative methods prepared in cooperation with the Society of the Plastics Industry, namely, the tear resistance of plastic film and sheeting (D 1004 – 49 T) and test for tensile properties of thin plastic sheets and films (D 882 – 49 T).

An important accomplishment was the revised method for haze and luminous transmittance of transparent plastics which comprises Procedure A using the hazemeter and Procedure B using the recording spectrophotometer. Other new tentative methods cover the measurement of changes in linear dimensions of plastics, the resistance of transparent plastics to surface abrasion and the stiffness properties of nonrigid plastics as a function of temperature by means of a torsional test.

The scope of the committee was enlarged some time ago to include plasticizers and in its current report it presented the first methods of sampling and testing plasticizers used in plastics. The test covered procedures for acidity, ester content, specific gravity and color. Work is also under way on specifications for plasticizers.

Two important additions were made to the specifications for molds for test specimens for plastic molding materials (D 647) covering a transfer type mold and a new injection type mold. The committee also submitted a new tentative recommended practice for transfer molding of specimens of phenolic materials. An extensive revision of the tentative specifications for phenolic molding compounds (D 700) was presented jointly with Committee D-9.

"E" GROUP

Committee E-1 on Methods of Testing

The large number of A.S.T.M. thermometer specifications have been thoroughly reviewed by Committee E-1 during the year and the changes will result in certain improvements and the elimination of inconsistencies.

The committee arranged for a Conference on Low-Temperature Testing of Elastomers and Plastic Materials at the request of Committee D-11 on Rubber and Rubber-like Materials. The considerable interest in this subject was evident from the attendance and nature of the discussion. At the meeting a task group was appointed to collect information as to what low-temperature tests are now being used. This will be done by means of a questionnaire to be sent to industrial laboratories, Government agencies, and other interested in low-temperature testing of these materials.

An organization meeting of the E-1 Task Group on Distillation Tests was held with representatives of the various interested A.S.T.M. technical committees attending. Consideration was given to the many distillation methods and variations in apparatus now covered by existing A.S.T.M. standards. The committee hopes that it will be possible to simplify and further standardize these distillation tests.

The initial meeting of another E-1 Task Group on Water Vapor Permeability was held. This group will survey the several existing A.S.T.M. methods to determine possible areas of simplification.

At a meeting of the Subcommittee on Indentation Hardness it was decided to undertake work on additional hardness conversion tables, rapid hardness methods, Vickers method, and Firth hardometer; also micro-hardness, the latter in cooperation with Committee E-4 on Metallography.

The Subcommittee on Compression Testing at its meeting reviewed new methods of compression testing of metallic materials in sheet form.

The Impact subcommittee discussed revisions in the tentative methods of impact testing of metallic materials (E 23 – 47 T) and also discussed possible work on other tests such as high-speed impact, Navy pile driver test and the Schnadt impact test.

The Subcommittee on Consistency, Plasticity and Viscosity reported that considerable data had now been collected on various methods for determining absolute viscosity. After suitable editing these methods are to be published as a basis for future work of the committee. Arrangements were made for a cooperative laboratory study of the proposed method for Saybolt Furol viscosity at high temperatures. The proposed consolidated ring and ball softening point method is still being studied by two committees and it is hoped that further action on the combined method may be possible by 1950.

Committee E-4 on Metallography

The Tentative Methods of Preparation of Micrographs of Metals and Alloys (E 2–44 T) have been extensively revised to include more and clearer information on the subject. The Standard Definition of Terms Relating to Metallography (E 7–27) and the Recommended Practice for Thermal Analysis of Steel (E 14–33) were reaffirmed.

Committee E-9 on Fatigue

The major project of Committee E-9 on Fatigue for some time has been the preparation of a "Manual on Fatigue Testing." This project was initiated at a meeting of the committee held during the Annual Meeting of the Society in Buffalo, N. Y. June, 1946, with the assignment of responsibility for various sections to individual committee members. Drafts of the several sections have been discussed at subsequent meetings of the committee at two Annual and three Spring Meetings of the Society, with appropriate revisions resulting. The Manual manuscript, which represents a reasonable consensus of committee opinion and experience, is now completed and needs only minor editorial changes. The publication should be available in the fall of 1949.

During the past year, liaison has been established through Dr. Herbert J. Gough between British work in the fatigue field and the work of Committee E-9. A special papers review committee has been

established. At the Annual Meeting, Prof. H. F. Moore, Chairman of the Research Subcommittee, presented a report summarizing several features of fatigue testing which seem to be especially significant.

Committee E-11 on Quality Control of Materials

Committee E-11 in its report announced plans for the organization of new task group on the sampling of bulk materials, on the smoothing of empirical data, and on problems connected with the use of the terms "precision," "accuracy," and allied terms. All of these subjects will be of interest to a number of other Society committees.

The committee reported progress on the new A.S.T.M. Manual on Quality Control of Materials. It is hoped that publication may be possible by the end of this year. This work represents a revision and considerable enlargement of the present A.S.T.M. Manual on Presentation of Data.

A recommended practice for conducting a laboratory study of test methods is in course of preparation. A survey of sampling plans used in A.S.T.M. standards is being made in such manner as to make statistical evaluation of these plans possible.

A revision of the Tentative E 29 – 48 T will be presented to the Society through the standards committee.

Glass Committee Advances Work

THOUGH limited to a luncheon meeting, a considerable amount of business was transacted by Committee C-14 on Glass, on April 26 at Cincinnati, Ohio. The meeting was held during the annual meeting of the American Ceramic Society inasmuch as the committee holds the dual status of representing the Standards Committee of the Glass Division of that society.

A further step in the publication of definitions of terms relating to glass and glass products (C 162 T) was taken in approving the submittal of a Glass Glossary for inclusion with this tentative. This glossary was originally compiled by the committee on Classification, Nomenclature and Glossary of the American Ceramic Society but will contain some revisions in order to conform with existing American Standards Association definitions. The two subcommittees on chemical analysis and chemical properties, respectively, are now soliciting the membership for new projects to be undertaken. A proposed tentative method of sampling and testing structural nonload-bearing cellular glass blocks were accepted for letter ballot.

Culminating several years' work in the study and development of methods of testing glass containers, four new methods were approved. The first, a proposed tentative method of sampling glass containers was referred to letter ballot of the committee. Three methods for testing durability have already been approved by letter ballot and are in process of submittal to the Society. These tests cover containers attacked by water, containers attacked by acid and a test on the powdered glass.

The Subcommittee on Flat Glass has had the opportunity to review and comment on the latest Federal Specification DD-G-451 relating to flat glass. A task force will develop a method of test for the abrasion resistance of glass.

Committee C-20 on Acoustical Materials Organizes

THE expansion of the Society's work into the field of acoustical materials will prove to be of much interest to all concerned with these sound absorbing products and the data and standards which will result should be of widespread value. The new Committee C-20 on Acoustical Materials was organized on May 3 at A.S.T.M. Headquarters with a very representative group of producers, consumers, and general interest members present. Previous to the organization meeting a conference had been held on February 17, with a resulting crystallizing of the thoughts and needs for standards on acoustical materials.

The scope for the committee reads as follows:

Scope: Study of the properties of those materials used to absorb air-borne sound, including the stimulation of research and the development of methods of tests, specifications, and definitions of terms.

The initial membership of the committee although consisting of over 50 members is still being augmented in order to obtain representation from the entire field.

It is interesting to note that, in the consideration of the activities of the committee, the problems encountered in application and maintenance seem to be most stressed. Among the properties for which test methods should be developed are those of absorptivity, combustibility, paintability, permanency, light reflectivity, application, maintenance, moisture, and breathing and discoloration. In setting up a working organization the committee voted to form initially the following subcommittees:

1. Sound absorption.
2. Fire resistance.
3. Maintenance.
4. Application.
5. Other physical properties.

It is proposed that the work of these subcommittees will include both the industrial and architectural phases of sound proofing although possibly the architectural phase will be stressed initially. The work will be coordinated and synchronized closely with existing projects conducted by such groups as Sectional Committee Z24 of the American Standards Association, Acoustical Society of America and others.

Personnel and Officers:

Permanent officers were elected as follows: H. A. Leedy, Armour Research Foundation, *Chairman;* C. M. Harris, Bell Telephone Laboratories, *Vice-Chairman;* H. J. Sabine, The Celotex Corporation, *Secretary.*

The Chairman was given authority to appoint a temporary Organization Subcommittee which will consider the over-all organization, By-laws, the appointment of subcommittee chairmen, possible subcommittee activities and routine administrative matters. This group has now taken action in the appointment of chairmen of subcommittees as noted below. The initial membership of the committee is as follows:

A.S.T.M. Committee C-20 on Acoustical Materials Initial Membership List

Chairman: H. A. Leedy
Vice-Chairman: C. M. Harris
Secretary: H. J. Sabine

	Chairmen
Subcommittee I on Sound Absorption	Hale Sabine
Subcommittee II on Fire Resistance	Wallace Waterfall
Subcommittee III on Maintenance	Peter Chrzanowski
Subcommittee IV on Application	B. L. Smith
Subcommittee V on Other Physical Properties	Wm. A. Jack

Consumers

American Institute of Architects	P. G. Knobloch
American Hospital Assn.	E. I. Behrman
Bell Telephone Laboratories	Cyril M. Harris R. L. Hanson
Contracting Plasterer's International Assn.	Albert Beever E. F. Venzie
*National Broadcasting Co.	H. M. Gurin
Public Buildings Administration	W. C. Clark
Public Health Service, Fed. Security Agency	E. B. Morris, Jr.
U. S. Dept. Air Forces (Air Matériel Command)	O. R. Rogers
U. S. Dept. of Navy, Bureau of Ships, and, New York Naval Shipyard	P. M. Barzilaski
U. S. Dept. of Navy, Bureau of Yards & Docks	W. J. Frick
U. S. Dept. of Navy, Electronics Laboratory	C. Burbank
Veterans Administration	L. F. Mulqueen
Voorhees, S. F.	*B. L. Smith

Producers

*Acoustical Materials Assn.	Wallace Waterfall
American Acoustics, Inc.	M. S. Lennard
Armstrong Cork Company	A. D. Park
Baldwin-Hill Co.	K. M. Ritchie
Certain-teed Products Corp.	R. P. Copeland
Gypsum Association	Chester E. Abbey
E. F. Houserman Co.	C. J. Nocar
Insulation Board Institute	S. M. Van Kirk
Johns-Manville Corp.	Wm. A. Jack
Kelley Island Lime & Transport Co.	R. G. Greeves
Lemmerman, C. W. (Industrial Sound Control)	C. W. Lemmerman
National Concrete Masonry Assn.	R. E. Copeland
National Gypsum Co.	W. L. Chrisler
Owens-Corning Fiberglas Corp.	B. M. Palmer
The Celotex Corp.	H. J. Sabine
U. S. Gypsum Co.	L. F. Yerges K. R. Larson
Vermiculite Institute	E. R. Murphy
Western Felt Works	R. F. Ettinger
Zonolite Company	R. F. Rea
Simpson Logging Co.	Don A. Proudfoot

General Interest

Acoustical Society of America	C. M. Harris K. C. Morrical
Armour Research Foundation	H. A. Leedy and H. C. Hardy
Battelle Memorial Institute	A. E. Pavlish
Mass. Inst. Technology, Acoustics Lab.	L. L. Beranek R. H. Bolt
National Bureau of Standards	Peter Chrzanowski R. K. Cook
University of Michigan	P. H. Geiger
University of Texas	R. B. Watson
U.S. Testing Company	T. Smith Taylor
A.S.T.M. Committees:	
C-7 on Lime	R. G. Greeves,
C-15 on Manufactured Masonry Units	R. E. Copeland
C-16 on Thermal Insulation	R. B. Crepps
D-1 on Paint, Varnish, Lacquer & Related Matls.	G. G. Sward
D-7 on Wood	L. J. Markwardt
D-14 on Adhesives	J. H. Wills
D-20 on Plastics	W. C. Goggin
E-5 on Fire Tests of Materials and Construction	
E-6 on Methods of Testing Building Constructions	R. K. Cook

* Consulting Members.

It was decided to plan the next meeting in conjunction with the Fall meeting of the Acoustical Society of America which will be held in St. Louis in November.

Much Work Under Way In A.S.T.M. Committee D-14 on Adhesives; Those Interested Invited to Participate

An invitation to those interested in adhesives to attend future meetings and participate in the work of A.S.T.M. Committee D-14 on Adhesives was extended by this group at its Spring meeting held at the Hotel Stevens in Chicago.

Publicity Chairman James F. Hamilton was asked to release information concerning the activities of this technical committee for the information of those who may wish to participate. Committee D-14 embraces the entire field of adhesives and is not limited to any special group of the more widely used materials. At the time the committee membership consisted of 32 consumer members, 36 producer members, and 17 general interest members. It is the feeling of the committee that a diversification of membership, reflecting as broad a range of adhesive applications as possible, would facilitate committee work and more accurately determine industry practice.

The development and approval of several tentative standard test methods have already been achieved. Tensile properties, the peel or stripping strength and applied weight per unit area are covered in standard methods. Resistance of adhesive bonds to chemical reagents is another standard, and the effect of light on permanence has been covered in a test. A series of definitions of terms has been standardized. Work on additional procedures, methods, specifications, and other objectives of the committee is progressing very satisfactorily. Those concerned with attaining some uniformity of procedure or practice for their phase of the adhesive industry are invited to participate in the activities of Committee D-14. The next meeting of this committee is scheduled for early October, 1949, in Philadelphia.

The Subcommittee structure of Committee D-14 is arranged according to: I. Strength Tests; II. Analytical Tests; III. Tests for Permanency; IV. Working Qualities; V. Specifications; VI. Nomenclature and Definitions; VII. Research Problems; and VIII. Electrical Properties of Adhesives.

Information and details concerning the activities of A.S.T.M. Committee D-14 can be obtained from George W. Koehn, Secretary, A.S.T.M. Committee D-14, Research Laboratories, Armstrong Cork Co., Lancaster, Pa.; J. H. Wills, Membership Secretary, Philadelphia Quartz Co., 121 South Third St., Philadelphia 6, Pa.; or from the A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

Printing Ink Test Methods and Standard Terminology to Be Developed in New A.S.T.M. Technical Group; Committee Organized in Atlantic City

At the invitation of the Society a meeting of manufacturers and users of printing inks was held in Philadelphia, at A.S.T.M. Headquarters, on May 18. The conference gave consideration to the need for standard test methods applicable in the evaluation of printing inks and materials used in their manufacture. Discussions at the meeting evidenced a great need also for standard terminology in connection with printing terms.

The conference decided to organize a Technical Committee on Printing Ink under the auspices of the A.S.T.M. In order to further the organization and the development of a program of work to be undertaken, the following were appointed as a steering committee:

A. C. Zettlemoyer (*chairman*), National Printing Ink Research Institute
G. L. Erikson, Braden Sutphin Ink Co.
M. S. Kantrowitz, U. S. Government Printing Office
E. O. Ryan, Curtis Publishing Co.
B. J. Taymans, Printing Industry of America, Inc.
M. Zucker, International Printing Ink, Div. of Interchemical Corp.

This steering committee held a meeting after adjournment of the conference and formulated plans for the appointment of working sections on nomenclature and definitions and for consideration of testing methods for: fineness of grind, drying time, tack and rubproofness. It was also decided to appoint a group to review present additional testing methods and available literature.

Present at the Philadelphia meeting were the following:

W. C. Walker, National Printing Ink Research Institute
G. L. Erikson, Braden Sutphin Ink Co.
W. F. Gerlach, Capitol Printing Ink Co., Inc.
J. Watson, J. M. Huber Corp.
E. P. Ryan, Curtis Publishing Co.
C. H. Rose, National Lead Co.
S. Werthan, N. J. Zinc Co. (of Pa.)
T. Rosevelt, Sun Chemical Co.
K. B. Latimer, Time-Life, Inc.
A. Voet, J. M. Huber Co.
M. S. Kantrowitz, U. S. Government Printing Office
E. F. Carman, Consultor
B. J. Taymans, Printing Industry of America, Inc.
C. A. Blessing, Container Corp. of America
M. Zucker, International Printing Ink, Div. of Interchemical Corp.
G. Cramer, Sinclair & Valentine Co.
A. C. Zettlemoyer, National Printing Ink Research Institute
J. C. Moore, National Paint, Varnish & Lacquer Assn., Inc.

Committee Formally Organized at Atlantic City Meeting:

The organization of the new committee, which is to function as a subcommittee of A.S.T.M. Committee D-1, was held during the A.S.T.M. Annual Meeting in Atlantic City. Paul J. Thoma, of Time-Life Publications, who had been elected chairman of the committee, presided. The very considerable interest in this project was evident not only from the excellent attendance but from the nature of the discussion and the numerous questions raised by those present. Brief informational reports were made on the following subjects:

Definitions
Methods Review
Fineness of Grind Gage
Drying Time
Rubproofness
Tack Measurement

There was considerable discussion as to the scope of work to be undertaken by the committee including raw materials, printing ink, and application of the ink to paper in various types of printing. The next meeting of this subcommittee will be held in Atlantic City during the first week in November.

Shipping Container Committee Points Toward Performance Standards

At the Spring meeting of Committee D-10 on Shipping Containers, held at the Hotel Claridge, Atlantic City, on May 9 and 10, it was interesting to note the trend of increased interest and activity toward the development of preformance standards and the correlation of data. This is a logical step in the sequence of the work of this committee. Up to this time the emphasis, of necessity, has been in developing test methods to be used as a means of measuring the resistance of shipping containers to the many conditions to which they are subjected. Committee D-10 now has 11 such methods published, together with a comprehensive list of definitions of terms relating to shipping containers.

The two-day meetings at Atlantic City attracted a very good attendance with 40 visitors also present and the six subcommittees submitted interesting reports. The proposed tentative method developed by Subcommittee III, R. H. Lahey, Chairman, and now submitted to the Society, covers two procedures for determining the water vapor permeability of bulk shipping containers, one being for reclosable and the other for nonreclosable containers.

The Subcommittee on Definitions under Chairman Edward Dahill considered an additional list of terms and after reviewing comments decided the terms should be further studied. A coordinated effort with Subcommittee VI is nearing completion in formulating an extensive list of terms pertaining to interior packing.

In the field of strength tests a new tentative method for testing large shipping cases and crates is nearing completion. This undoubtedly will include a drop test, a test for superimposed loading and a test for lifting by grabhooks. Further refinements in the drop test for bags and sacks and incline-impact test are being considered. No need was felt for the preparation of a hydrostatic test for cylindrical containers after investigation by a section of the subcommittee, the method now set up by the Bureau of Explosives, A.A.R., being considered satisfactory. Likewise it was felt that a torsion test for containers would provide no information not now obtainable from other existing tests. A puncture test for bags is still in the course of development.

A program has been proposed by Subcommittee V, R. C. McKee, Chairman, to obtain data from various laboratories on rough handling tests so that variability within test lots can be determined to serve as a yardstick in evaluating the significance of these tests. Then round-robin tests will be made to obtain information on the degree of correlation between laboratories.

Subcommittee VI on Interior Packing, W. B. Lincoln, Jr., Chairman, reported that work is continuing on a bibliography and that a total of 184 interior packing terms have been con-

(*Continued on page 34*)

List of New and Revised Tentatives with Serial Designations

THE Society accepted at the Annual Meeting 78 new tentatives and revisions in 104 existing tentative specifications and methods of test. Of the revised tentative specifications and methods, 20 have been extensively revised and the titles of these are given below (marked with an asterisk) with the list of those issued by the Society for the first time. Technical committees responsible for the various items are indicated.

Steel

(*Committee A-1*)

Specifications:
*Cold-Rolled Carbon Steel Strip (A 109–49T) (Revision of standard and reversion to tentative).

Corrosion of Non-Ferrous Metals and Alloys

(*Committee B-3*)

Method:
*Salt Spray (Fog) Testing (B 117–49T).

Copper and Copper Alloys, Cast and Wrought

(*Committee B-5*)

Recommended Practice:
*Tension Test Specimens for Copper-Base Alloys for Sand Castings (B 208–49T).

Die-Cast Metals and Alloys

(*Committee B-6*)

Specifications:
Zinc-Base Alloys in Ingot Form for Die Castings (B 240–49T).

Light Metals and Alloys, Cast and Wrought

(*Committee B-7*)

Specifications:
Aluminum-Alloy Pipe (B 241–49T).

Electrodeposited Metallic Coatings

(*Committee B-8*)

Recommended Practices:
Preparation of High-Carbon Steel for Electroplating (B 242–49T).

Metal Powders and Metal Powder Products

(*Committee B-9*)

Definitions:
Terms Used in Powder Metallurgy (B 243–49 T).

Cement

(*Committee C-1*)

Specifications:
Flow Table for Use in Tests of Hydraulic Cement (C 230–49 T).
*Natural Cement (C 10–49 T).

Methods of Test:
Sodium Oxide and Potassium Oxide in Portland Cement by Flame Photometry (C 228–49 T).
Setting Time of Hydraulic Cement (C 229–49 T).

Concrete

(*Committee C-9*)

Methods of Test:
Bleeding of Concrete (C 232–49 T).
Air Content of Freshly Mixed Concrete by the Pressure Method (C 231–49 T).
Air-Entraining Admixtures for Concrete (C 233–49 T).
Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel (C 234–49 T).

Concrete Aggregates and Road Materials

(*Committees C-9 and D-4*)

Method of Test:
Soft Particles in Coarse Aggregates (C 235–49 T).

Thermal Insulating Materials

(*Committee C-16*)

Method of Test:
Thermal Conductance and Transmittance of Built-Up Sections by Means of the Guarded Hot Box (C 236–49 T).

Pigments and Paint Materials

(*Committee D-1*)

Methods of Test:
Acetone Number of Heat-Bodied Drying Oils (D 1009–49 T).
Bituminous Emulsions for Use as Protective Coatings for Metal (D 1010–49 T).
Night Visibility of Traffic Paints (D 1011–49 T).
Aniline Point and Mixed Aniline Point of Hydrocarbon Solvents (D 1012–49 T).
Total Nitrogen in Resins for Surface Coatings (D 1013–49 T).
Conducting Exterior Exposure Tests of Paints on Steel (D 1014–49 T).
*60-Degree Specular Gloss of Paint Finishes (D 523–49 T).

Petroleum Products and Lubricants

(*Committee D-2*)

Methods of Test:
Acetylene in Polymerization Grade Butadiene by Silver Nitrate Method (D 1020–49 T).
Oxygen in Butadiene Vapors by Manganous Hydroxide Method (D 1021–49 T).
Peroxides in Butadiene by Ferrous-Titanous Method (D 1022–49 T).
Separation of Residue from Butadiene (D 1023–49 T).
Butadiene Dimer in Polymerization Grade Butadiene (D 1024–49 T).
Nonvolatile Residue of Polymerization Grade Butadiene (D 1025–49 T).
Sodium in Lubricating Oils and Lubricating Oil Additives (D 1026–49 T).
Measurement of Freezing Points for Evaluation of Purity (D 1015–49 T.)
Determination of Purity from Freezing Points (D 1016–49 T).
Olefinic Plus Aromatic Hydrocarbons in Petroleum Distillates (D 1019–49 T).
Hydrogen in Petroleum Fractions by the Lamp Method (D 1018–49 T).
Benzene and Toluene by Ultraviolet Spectrophotometry (D 1017–49 T).
*Penetration of Petrolatum (D 937–49 T).
*Kinematic Viscosity (D 445–49 T).
*Aromatic Hydrocarbons in Olefin-Free Gasolines by Silica Gel Adsorption (D 936–49 T).
Free and Corrosive Sulfur in Petroleum Products (D 130–49 T).
Oil Content of Paraffin Wax (D 721–49 T).

Paper and Paper Products

(*Committee D-6*)

Methods of Test:
Creasing Paper for Permeability Tests (D 1027–49 T).
Fiber Analysis of Paper and Paperboard (D 1030–49 T).
Ply Separation of Combined Container Board (D 1028–49 T).
Scuff Resistance of Paperboard (D 1029–49 T).

Wood

(*Committee D-7*)

Specifications:
Creosoted End-Grain Wood Block Flooring for Interior Use (D 1031–49 T).
Chromated Zinc Chloride (D 1032–49 T).
Tanalith (D 1034–49 T).
*Creosote-Coal Tar Solution (D 391–49 T) (Revision of standard and reversion to tentative).
*Zinc Chloride (D 432–49 T) (Revision of standard and reversion to tentative).

Methods:
Chemical Analysis of Chromated Zinc Chloride (D 1033–49 T).
Chemical Analysis of Tanalith (D 1035–49 T).
Static Tests of Wood Poles (D 1036–49 T).
Test for Evaluating the Properties of Building Boards (D 1037–49 T).
*Chemical Analysis of Zinc Chloride (D 199–49 T) (Revision of standard and reversion to tentative).

Electrical Insulating Materials

(*Committee D-9*)

Definitions:
Terms Relating to Plywood and Veneer (D 1038–49 T).

Methods of Test:
Electrical Resistance of Insulating Materials (D 257–49 T) (Revision of standard and reversion to tentative).
Glass-Bonded Mica Used as Electrical Insulation (D 1039–49 T).

Recommended Practices:
Purchase of Uninhibited Mineral Oil for Use in Transformers and Oil Circuit Breakers (D 1040–49 T).

Maintaining Constant Relative Humidity by Means of Aqueous Solutions (D 1041–49 T), jointly with Committee D-20.

Rubber and Rubber-Like Materials

(Committee D-11)

Specifications:
- Thermoplastic Vinyl Polymer Sheath Compound for Electrical Insulated Cords and Cables (D 1047–49 T).
- Rubber Insulating Blankets (Without Fabric Reinforcement) (Proof Test 16,000 Volts, 3 Minutes) (D 1048–49 T).
- Rubber Insulator Hoods (Proof Test 20,000 Volts, 3 Minutes) (D 1049–49 T).
- Rubber Insulating Line Hose (Proof Test 20,000 Volts, 3 Minutes) (D 1050–49 T).
- Rubber Insulating Sleeves (Proof Test 10,000 Volts, 3 Minutes) (D 1051–49 T).

Specifications and Methods of Test:
- Latex Foam Rubbers (D 1055–49 T).
- Sponge and Expanded Cellular Rubber Products (D 1056–49 T).

Methods of Test:
- Resistance of Vulcanized Rubber or Synthetic Elastomers to Cut Growth by the Use of the Ross Flexing Machine (D 1052–49 T).
- Measuring Low-Temperature Stiffening of Rubber and Rubber-Like Materials by the Gehman Torsional Apparatus (D 1053–49 T).
- Impact Resilience and Penetration of Rubber by the Rebound Pendulum (D 1054–49 T).

Textile Materials

(Committee D-13)

Specifications and Methods of Test:
- Asbestos Lap (D 1061–49 T).

Methods:
- Core Sampling of Wool in Packages for Determination of Percentage of Hard Scoured Wool Content (D 1060–49 T).
- Testing Single Kraft Yarn (D 1057–49 T).
- Test for Stretch of Hosiery (D 1058–49 T).
- Test for Yarn Number of Yarn from Fabrics (D 1059–49 T).
- *Testing and Tolerances for Cotton Yarns (D 180–49 T).
- *Testing Cotton Fibers (D 414–49 T).
- *Testing and Tolerances for Glass Yarn (D 578–49 T).
- *Test for Resistance of Textile Fabrics and Yarns to Insect Pests (D 582–49 T).

Adhesives

(Committee D-14)

Method:
- Test for Cleavage Strength of Metal-to-Metal Adhesives (D 1062–49 T).

Naval Stores

(Committee D-17)

Methods of Test:
- Ash in Rosin (D 1063–49 T).
- Iron in Rosin (D 1064–49 T).
- Unsaponifiable Matter in Rosin (D 1065–49 T).
- *Saponification Number of Rosin (D 464–49 T).
- *Acid Number of Rosin (D 465–49 T).

Industrial Water

(Committee D-19)

Specifications:
- *Phenolic Molding Compounds (D 700–49 T), jointly with Committee D-9.

Methods of Test:
- Sampling Steam (D 1066–49 T).
- Acidity and Alkalinity in Industrial Waters (D 1067–49 T).
- Suspended and Dissolved Solids in Industrial Waters (D 1069–49 T).
- Iron in Industrial Water (D 1068–49 T).

Plastics

(Committee D-20)

Methods of Test:
- Haze and Luminous Transmittance of Transparent Plastics (D 1003–49 T).
- Measuring Changes in Linear Dimensions of Plastics (D 1042–49 T).
- Stiffness Properties of Nonrigid Plastics as a Function of Temperature by Means of a Torsional Test (D 1043–49 T).
- Resistance of Transparent Plastics to Surface Abrasion (D 1044–49 T).
- Sampling and Testing Plasticizers Used in Plastics (D 1045–49 T).

Recommended Practice:
- Transfer Molding of Specimens of Phenolic Materials (D 1046–49 T).

Metallography and Non-Destructive Testing

(Committees E-4 and E-7)

Methods:
- *Preparation of Micrographs of Metals and Alloys (E 2–49 T).

Terminology:
- *Industrial Radiographic Terminology for Use in Radiographic Inspection of Castings and Weldments (E 52–49 T).

70 Technical Papers in 15 Sessions at Pacific Area National Meeting

Members urged to Return Hotel Reservations and Travel Forms

San Francisco, October 10–14, 1949

Hotel Fairmont, with Mark Hopkins and Others Cooperating

THE complete technical program for the First A.S.T.M. Pacific Area National Meeting was published in a special 16-page announcement sent in June to all members and committee members. The 70 papers were listed with the authors, and while some changes will occur from time to time the general make-up of the program will remain essentially as announced.

This folder included a message from President Templin and from Dozier Finley, Chairman of the General Committee on Arrangements, and gave details of other parts of the meeting including a list of the technical committees meeting, entertainment and social activities, and the personnel of the several committees responsible for various meeting events.

Members Urged to Return Travel and Hotel Forms:

The General Committee on Arrangements, and particularly the Chairman of the A.S.T.M. Housing Bureau, S. L. Davidson, is very anxious that members return the hotel application form as soon as possible. This form was page 16 of the announcement; extra copies of the form are available from A.S.T.M. Headquarters.

Likewise the Committee on Travel and Transportation hopes that all members interested in travel by rail particularly, and also by other methods of public transportation, return the form printed with the folder at their earliest convenience. This will enable P. V. Garin, Chairman of the Transportation Committee, to make his plans for special trains or cars, etc.

Changes in Technical Program:

Some changes have already occurred in the technical program including the withdrawal of two papers: one concerned the Session on Soils, dealing with the settlement of fill in certain approaches to the San Francisco-Oakland Bay Bridge; the other, a part of the Symposium on Cast Iron, dealt with the use of cast iron at elevated temperatures. Some of the information and data, however, in this latter proposed paper will be included in the contributions of another author. A rather significant change in title has been made in one of the papers in the Discussion on Testing Paints and Paint Materials: listed as "Lacquer Tests" the paper actually will deal with "Some Aspects of Cold-Check Testing Practice—A Survey of the Furniture Finishes Field." There have been some other changes including additional authors, and there will be two additional discussions in the Symposium on High Additive Content Oils. Announcement of further changes in the program will be made to the members in the September BULLETIN or by mail.

Extra Copies of Announcement

Any members or committee members who would like to have extra copies of the 16-page announcement can procure these from A.S.T.M. Headquarters. Those responsible for the meeting wish to place full information about it in the hands of any engineers and others who are interested.

San Francisco's Dining Out Guide

Dr. Raymond H. Ewell has prepared a most interesting booklet of some 100 pages entitled "San Francisco's Dining Out Guide" which, in the words of the author, includes "Forthright and Unbiased Notes on Selected Restaurants, Cafes, Grills, Grottos, Rendezvous and Hotel Dining Rooms of San Francisco and Bay Area." A great deal of pertinent information is included and the editorial style makes for easy reading. This book is available from leading bookstores and newsstands in the San Francisco Bay Area at a price of $1 (Brentano's Book Store at the corner of Geary at Stockton St.; Books, Inc., at 336 Sutter; and John Howell's Store, 434 Post, among others).

California Street with its Cable Cars. In the Distance a tower of the Oakland Bay Bridge.

Publication Plans

As THE recent annual meeting becomes history, plans are being laid for the publication of the material presented. Fortunately a much larger portion of the reports and papers were set in type and preprinted in advance of the meeting which should make it possible to effect final publication quite expeditiously. This applies particularly to the technical papers which will now be gathered together with the discussion and the technical reports in the annual *Proceedings*.

The actions on standards both with respect to the adoption as standard of tentative specifications and methods, and the acceptance for publication of new tentatives will all be reflected in the new 1949 Book of Standards to be issued the latter part of the year and in the early months of 1950.

One of the first publications to be taken in hand will be the Manual on Fatigue Testing referred to at the meeting. This should be available within the next few months.

It is also expected that the Compilation of Data on Wrought and Cast Stainless Steel Products will be available during the next few months.

The usual compilations of standards will be issued and work on these will proceed concurrently with the Book of Standards. One of the first of these will be the C-1 Compilation on Cement to be followed shortly by the Compilation of Standards on Textile Materials.

A new Compilation of Methods of Testing Soils is now in preparation, and in view of the very considerable demand and use that have been made of the previous edition, every effort is being made to bring out this compilation as promptly as possible.

A number of special technical publications are in process including the Symposium on Color Metallography presented a year ago, a further printing of X-ray transparencies for defects in steel castings, a new edition of the X-ray diffraction data cards and the printing of transparencies for the grading of mica.

Future publications.—As soon as possible, work will be undertaken on a number of symposiums held at the annual meeting. These cover Evaluation Tests for Stainless Steels, Accelerated Durability Testing of Bituminous Materials, Rapid Methods for the Identification of Metals, Radiography, Ultrasonic Testing, and Testing Cast Iron with SR-4 Type of Gage.

Plan to be in San Francisco October 10–14, 1949

ASTM Bulletin

JULY 1949

NO. 159

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

A.S.T.M. Award of Merit Established

Technical Committees Can Nominate

THE Board of Directors has had under consideration for some time proposals that there be established an A.S.T.M. Award of Merit to recognize individuals who have rendered distinguished service to the Society. As indicated in the Annual Report of the Board (page 15) such an award is now set up, and the rules and regulations covering the award are published below. This information has been sent to the officers of all A.S.T.M. technical committees since these committees through the nominations which they may develop have an essential part in the awards.

It is expected that the "Award of Merit" Committee will recommend the first awards to the Board of Directors in 1950.

The rules governing the award follow:

A.S.T.M. AWARD OF MERIT

1. *Establishment of Award.*—The Society shall establish an "Award of Merit" which may be granted annually at times and places determined by the Board of Directors, to individuals for distinguished Service to the Society as hereinafter provided.

2. *Basis of Award.*—Any or all of the following types of service shall be considered as the basis for the Award of Merit:

(*a*) Long active productive service in A.S.T.M. committee work.

(*b*) Marked leadership in technical, administrative, or special committee or society activities.

(*c*) Outstanding contribution in the form of research, development of apparatus, or test methods and procedures not specifically recognized or duplicated by any of the other Society awards.

(*d*) Publication of papers that have been of special benefit to the work of the Society or of a committee.

(*e*) Outstanding activity or service that has particularly advanced the Society's prestige, standing, or interest.

(*f*) Any distinguished service to the Society not herein otherwise specifically provided for.

3. *Number of Awards.*—The number of awards granted in any one year shall not exceed one per 750 members, or fraction thereof.

4. *Method of Selection.*—(*a*) The awards shall be granted by the Board of Directors on recommendation of a special "Award of Merit" Committee of five to be appointed annually by the President, with approval by the Board, on or before January 1 of each year. One member of the Committee shall be from the Board of Directors, to serve for one year. The term of the other four members shall be staggered, and of two years' duration.

(*b*) One nomination, accompanied by an appropriate citation, may be made annually (but not necessarily need be made annually) by each technical committee, but its Advisory Committee, or by a special committee appointed by the Chairman or appointed by the Advisory Committee.

Other nominees may be selected by the "Award of Merit" Committee from members participating in other areas of the Society's work.

(*c*) Provided qualified candidates are available, it is the intent that the awards made annually from among technical committee members be equitably distributed among the several general committee groups A, B, C, D, and E.

(*d*) All nominations for the Award of Merit shall be in the hands of the Executive Secretary of the Society for consideration by the "Award of Merit" committee not later than February 1 of each year.

5. *Form of Award.*—The "Award of Merit" shall consist of an appropriate certificate, duly authenticated, bearing in suitable manner the name of the Society and the name of the award in such form and manner as may be designated and approved for this purpose by the Board. A special "Award of Merit" pin or button, appropriately designed, shall be made optionally available for purchase by those to whom the award is granted.

Society Continues to Grow

THE weather is probably too hot in most places for the comfortable digestion of statistics, but it will be of interest to most members to know that the number of new members who joined A.S.T.M. during the month of June was considerably higher than for the same period a year ago. Also the total number of new members for the first six months of 1949 reached 451 compared with 429 for the same period last year. Another figure which is quite significant involves the losses and they are significantly lower this year than for 1948.

All of this adds up to encouragement for the Membership Committee. Two factors might be mentioned as influencing the membership curve rather markedly, the first being the larger-than-usual number of committee members who became personally affiliated with the Society during the late spring. The other factor, and unquestionably the most influential, is the great help and cooperation extended by current members in contacting many individuals and companies who received invitations from the Membership Committee to join the Society. By personal contact, telephone and letter, and in other ways our members have aided in procuring many new members. The reports which come back to us including the letters which have been written by our members afford one of the finest groups of testimonials which any organization might have. These statements on the value and worth-whileness of A.S.T.M. work as seen through the eyes of many individual members are heartening and inspiring.

1950 National Meetings in Atlantic City and Pittsburgh

DECISION HAS been reached by the Board of Directors to return to Atlantic City for the 1950 Annual Meeting, using Chalfonte-Haddon

Hall as convention headquarters. This will be the fifty-third meeting, and the Ninth Exhibit of Testing Apparatus and Related Equipment will be held in conjunction with the meeting, also at Haddon Hall, during the week of June 26–30, inclusive.

The 1950 Spring Meeting and A.S.-T.M. Committee Week will be held in Pittsburgh during the week February 27 through March 3. Reservations have been made at the William Penn Hotel.

1949 Directors Report in New Format; Important Items Covered

THE 1949 Annual Report of the Board of Directors as submitted at the Annual Meeting was printed in advance as is customary, but the typography and format used were a departure from earlier reports. A short message from the president was included and a one-page summary of the report highlighted the major points detailed. Then followed in accordance with the listings in the Table of Contents, the announcements and review of the various matters which the Board wished to cover adequately in this message to the members. A separate title page was used this year and there were other changes.

Extra copies of this report are available and members who did not receive one can obtain a copy promptly from A.S.T.M. Headquarters. The report will be included in the 1949 *Proceedings*.

Numerous Actions on Standards Submitted to Members for Letter Vote

AT THE 1949 Annual Meeting in Atlantic City approval was given to submit to letter ballot of the Society proposals from the technical committees involving some 181 standards and tentatives. These proposals, as listed on the letter ballot which will be mailed to the entire membership in July–August, fall into two categories, namely, the adoption of tentative specifications and tests as formal standards, and the adoption of revisions in existing standards.

The letter ballot on the actions on standards will be canvassed on September 15.

In connection with the actions on standards it should be noted that only by letter ballot of the entire Society membership can changes be made in the formal standards. The action of an annual meeting session alone, or in the interval between annual meetings the Administrative Committee on Standards, can approve for publication as *tentative* proposed new standards, can approve *revisions in tentative standards* (which are incorporated immediately), or can take action to permit publication as *tentative of proposed revisions in standards*. Many such actions, of course, are taken at the Annual Meeting and throughout the year by the Administrative Committee on Standards.

A complete list of the items to be voted upon appears in the letter ballot being sent in separate mailing to the members. Detailed information concerning most matters referred to letter ballot is given in the committee reports issued in preprint form to the membership in advance of the meeting. The *Summary of Proceedings* accompanying the letter ballot contains a record of all actions taken at the Annual Meeting.

All newly adopted and revised standards will be published in the six-part 1949 Book of A.S.T.M. Standards. The respective parts will be furnished to the members in accordance with instructions on file at Headquarters. In the meanwhile a number of the standards together with all new tentatives approved at the Annual Meeting or through the Administrative Committee on Standards will be published in some of the special compilations of standards or as separates. Details of the Society's extensive publication schedule will be given in the September BULLETIN.

September 1-Last Day for Annual Meeting Papers Discussion

MUCH of the discussion of technical papers and reports published in the *Proceedings* is submitted after the meeting "by letter." Written discussion of papers and reports presented at the 1949 Annual Meeting in Atlantic City will be received by the Committee on Papers and Publications until September 1. It will be greatly appreciated if all who plan to submit such discussion will do so well in advance of this date so that additional time is available for review and submission to authors for closure.

Dudley Medal Committee Enlarged

EACH year the three members of the Committee on Award of the Charles B. Dudley Medal review all of the eligible technical papers for this award which recognizes that paper of outstanding merit constituting an original contribution on research in engineering materials. A great amount of work is devoted to this study by the Medal Committee, and recently on recommendation of the current group the Board of Directors has approved the enlargement of the committee to six members, with a three-year term on a rotation basis. Each year the Board will designate as chairman one of the two senior members on the committee.

An announcement of the current winners of the Medal appears in the Annual Meeting article in this BULLETIN, and the members to serve on the Medal Committee will be announced in the section of the BULLETIN on appointments.

Schedule of A.S.T.M. Meetings

DATE	GROUP	PLACE
September 19–20	Board of Directors Meeting	Philadelphia, Pa.
September 22	Committee C-8 on Refractories	Bedford Springs, Pa.
September 22–23	Committee D-15 on Engine Antifreezes	New York, N. Y.
October 6–7	Committee D-10 on Shipping Containers	Detroit, Mich.
October 10–14	1949 Pacific Area Meeting	San Francisco, Calif.
October 19–21	Committee D-13 on Textiles	Philadelphia, Pa.
November 3	St. Louis District	St. Louis, Mo.
1950		
February 27–March 3	Committee Week and Spring Meeting	Pittsburgh, Pa.
June 26–30	53rd ANNUAL MEETING and 9th Exhibit of Testing Apparatus and Equipment	Atlantic City, N. J.

District Officers and Personnel

The District Councils of the Society have conducted an election of councilors (except as noted below, all terms are for the ensuing two years) under the A.S.-T.M. Charter for Districts, which has been in effect since January 1, 1947. This charter provides that councilors (and officers in the even-numbered years) shall be elected by the A.S.T.M. members and committee members in the respective districts. Ballots were distributed in May, and all councilors listed on the ballots on recommendation of the respective Nominating Committees were elected.

The list of current officers and new or reelected councilors is given below. Newly elected councilors are indicated by an asterisk (*).

Several of the districts have already planned fall meetings, and members are urged to watch the BULLETIN for specific dates and topics of meetings to be sponsored. During the past year several technical meetings sponsored by the districts have resulted in very interesting papers and publications.

As soon as possible after meeting details are definite, each member and committee member in the specific area receives a direct-mail notice, and usually other groups of technical men in the area concerned with the subject under discussion are also invited.

A complete list of district councilors will appear in the 1949 Year Book. Many of the councilors' terms carry through 1950, and the list below notes only officers, newly elected councilors and reelections of those whose terms expired in 1949.

List of New or Reelected District Councilors as of June, 1949

(For complete list see 1949 Year Book, now in preparation)

Chicago

Chairman: J. J. Kanter, Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.; *Vice-Chairman:* J. de N. Macomb, 105 E. Delaware Place, Chicago 11, Ill.; *Secretary:* G. E. Stryker, Bell & Howell Co., 7100 McCormick Blvd., Chicago 45, Ill.

Councilors: L. H. Amrine, Imperial Molded Products Corp.; W. L. Bowler, The Pure Oil Co.; J. F. Calef, Automatic Electric Co.; D. L. Colwell, Apex Smelting Co.; F. A. Faville,* Faville-LeVally Corp.; H. P. Hagedorn,* City of Chicago, Bureau of Engr.; C. H. Jackman, Carnegie-Illinois Steel Corp.; A. M. Johnsen, The Pullman Co.; H. B. Knowlton, International Harvester Co.; R. P. Lutz,* Western Electric Co.; E. F. Pohlman, The Peoples Gas Lignt & Coke Co.; D. D. Rubek, Anderson-Prichard Oil Corp.; L. E. Simon,* Electromotive Div. of General Motors Corp.

Cleveland

Chairman: A. J. Tuscany, Arthur J. Tuscany Organization, Trade Association and Management, 1006 Engineers Bldg., Cleveland 14, Ohio; *Vice-Chairman:* R. T. Bayless, American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio; *Secretary:* H. P. Ferguson, Standard Oil Co. Ohio, Midland Building, Cleveland 15, Ohio.

Councilors: Walter Bonsack, Apex Smelting Co.; H. D. Churchill, Case Institute of Technology; G. W. Flanagan, The B. F. Goodrich Chemical Co.; H. H. Gorrie, Bailey Meter Co.; L. F. Herron, The James H. Herron Co.; M. E. Marks, The Pittsburgh Plate Glass Co.; R. B. Textor, The Textor Laboratories.

Detroit

Chairman: F. P. Zimmerli, Barnes-Gibson-Raymond Div., Associated Spring Corp., 6400 Miller Ave., Detroit, 11, Mich.; *Vice-Chairman:* C. E. Heussner, Chrysler Corp., 12800 Oakland Ave., Detroit 31, Mich.; *Secretary:* C. M. Gambrill, Research Labs., Ethyl Corp., 1600 Eight Mile Rd., Detroit 20, Mich.

Councilors: T. A. Boyd,* General Motors Corp.; M. R. Caldwell, Jarvis* Div., Doehler-Jarvis Corp.; B. C. Case,* Hanson-Van Winkle-Munning Co.; V. M. Darsey, Parker Rust-Proof Co.; A. C. Eichenlaub, Peerless Cement Co.; F. C. Kennedy, U. S. Rubber Co.; J. L. McCloud, Ford Motor Co.; Robert Sergeson,* Rotary Electric Steel Co.; G. R. Thompson,* Dept. of Public Works, City of Detroit; C. E. Topping, Consumers Power Co.; H. A. Wagner, The Detroit Edison Co.

New England

Chairman: M. N. Clair, The Thompson and Lichtner Co., Inc., 8 Alton Place, Brookline 46, Mass.; *Vice-Chairman:* E. A. Gramstorff, Northeastern University, Boston 15, Mass.; *Secretary:* C. G. Lutts, Boston Naval Shipyard, Building 34, Boston 29, Mass.

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Pittsburgh

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* Newly elected councilors.
† Councilors elected for one year term only.

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Chairman: J. C. Hostetter, Mississippi Glass Co., Main and Angelica Sts., St. Louis 7, Mo.; *Vice-Chairman:* S. B. Roberts, Robert W. Hunt Co., 1403 Syndicate Trust Bldg., St. Louis 1, Mo.; *Secretary:* J. M. Wendling, City of St. Louis, Municipal Testing Lab., 55 Municipal Courts Bldg., St. Louis 3, Mo.

Councilors: E. P. Buxton, Western Cartridge Co.; D. S. Eppelsheimer,* Mo. School of Mines & Metallurgy; P. G. Herold,* Mo. State Mining Exp. Station; L. C. Hewitt,† Laclede-Christy Clay Products Co.; W. W. Horner, Horner and Shiffrin; W. C. Magruder, Carter Carburetor Co.; E. B. Seaton,† Monsanto Chemical Co.; R. W. Notvest, American Brake Shoe Co.; F. V. Reagel, Mo. State Highway Dept.; E. J. Sheppard,† National Lead Co.; H. N. von Schrenk, Consulting Timber Engineer; L. A. Wagner,† Mo. Portland Cement Co.; A. C. Weber,* Laclede Steel Co.; F. G. White, Granite City Steel Co.

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Chairman: C. E. Emmons, The Texas Company, 929 S. Broadway, Los Angeles 15, Calif.; *Vice-Chairman:* F. J. Converse, California Institute of Technology, 1201 E. California St., Pasadena 4, Calif.; *Secretary:* H. W. Jewell, Pacific Clay Products, 306 W. Ave. 26, Los Angeles 31, Calif.

Councilors: E. O. Bergman,* C. F. Braun & Co.; M. F. Hasler,* Applied Research Labs.; E. F. Green, Axelson Manufacturing Co.; E. L. Johnson, Concrete Conduit Co.; H. E. Jung, Southern California Edison Co., Ltd.; N. W. Kelch, Research Engineer & Architect; J. B. Morey, The International Nickel Co., Inc.; R. G. Osborne, Raymond G. Osborne Testing Labs.; R. E. Paine, Aluminum Company of America; C. M. Wakeman, Los Angeles Harbor Dept.

Washington, (D. C.)

Chairman: H. F. Clemmer, Engineer Dept., District of Columbia, 203 Bryant St., N. W., Washington 1, D. C.; *Vice-Chairman:* Shreve Clark, Virginia Department of Highways, 1221 E. Broad St., Richmond 19, Va.; *Vice-Chairman:* A. L. Feild, Rustless Iron and Steel Div., Armco Steel Corp., 3400 E. Chase St., Baltimore 13, Md.; *Vice-Chairman:* G. M. Kline, Organic Plastics Section, National Bureau of Standards, Washington 25, D. C.; *Secretary:* Theodore Irving Coe, American Institute of Architects, The Octagon, 1741 New York Ave., N. W., Washington 6, D. C.

Councilors: W. D. Appel, National Bureau of Standards; A. C. Fieldner, U. S. Bureau of Mines; A. T. Goldbeck, National Crushed Stone Assn., Inc.; C. M. Hewett, Mexican Petroleum Corp.; E. L. Holladv, Army Service Forces; T. C. Jarrett, Koppers Co.; W. H. Reynolds, American Instrument Co.; Stanton Walker, National Sand and Gravel Association.

Western New York–Ontario

Chairman: O. W. Ellis, Ontario Research Foundation, 43 Queen's Park, Toronto 5, Ont., Canada; *Vice-Chairman:* L. F. Hoyt, National Aniline Div., Allied Chemical & Dye Corp. Box 975, Buffalo 5, N. Y.; *Vice-Chairman:* L. V. Foster, Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.; *Secretary:* Joseph Gentile, Pittsburgh Testing Laboratory, 257 Franklin St., Buffalo 2, N. Y.

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Opacity and Its Development in Porcelain Enamels at St. Louis District Meeting, May 11

Dr. Andrew I. Andrews, Professor of Ceramic Engineering at the University of Illinois, was the speaker at a joint meeting with the American Ceramic Society held in St. Louis on May 11.

The fundamental physical principles involved in the development of opacity in porcelain enamels were reviewed with an explanation of the phenomena of reflection, refraction, absorption, and diffraction, as they enter into the development of opacity. The laboratory equipment used in the measurement and control of this property was described from slide diagrams and the factors controlling the development of opacity, such as smelting time and temperature, the firing time and temperature, the compositions of the enamel, were discussed and many curves were shown indicating the effects of variation in these conditions.

The laboratory equipment slides included a complete description of a reflectometer and a smaller Handy reflectometer. The different materials that have been used in the frit were also reviewed, together with the effects of thickness of the tendency of the material to chip.

Dr. Andrews graciously responded with pertinent facts in answer to the many questions that came forth during the discussion period at the close of his address.

This meeting which was held at the York Hotel, was arranged by J. C. Hostetter, Mississippi Glass Co., District Chairman, and District Secretary J. M. Wendling, City of St. Louis, Municipal Testing Lab., in close conjunction with the officers of the St. Louis Section of the American Ceramic Society.

Committee D-10

(*continued from page 26*)

sidered. It is expected that this latter project will be pushed to completion in the very near future in cooperation with the Subcommittee on Definitions.

A resolution was read and recorded covering the death of Charles G. Weber, an active member of the committee since its inception. Due to an unexpected delay in arrival by plane, a talk by R. A. O'Reilly, Jr., General Motors Corp., was cancelled. This talk, entitled "Standard Packaging Nomenclature in General Motors," was anticipated with considerable interest and to offset the disappointment copies are being reproduced by Secretary Stivers for distribution to the membership.

Concerning performance standards, this subcommittee with J. H. Toulouse as Chairman, held a very fruitful meeting with much discussion which might be summarized as follows:

1. A weight breakdown is fundamental.
2. Load density must be considered.
3. Each shipping method has its own factor.
4. The end point of testing and shipping must be:
   (*a*) That the container retain the products.
   (*b*) That the container protect the contents.
5. We need *data*, rather than *opinions*, as to shipping performance and correlative test performance.
6. The governing shipping method for performance standards shall be LCL, with other methods rated up or down from LCL with respect to performance standard.

The next meeting of the committee is now scheduled for October 6 and 7 at the Hotel Statler, Detroit, Mich., following the meetings of the Industrial Packaging Engineers of America.

Errata

Discussion of the Paper on the Pressure Method for Air Content of Mortars

B. Janer's discussion, published in the ASTM Bulletin, No. 158, May, 1949, pages 65–67, of the above paper by T. G. Taylor, contains several typographical errors which should be corrected as follows:

Delete the second B in Eq. 3*c* on page 66. The equation should read $G = 0.474\ B + 1.453 + 0.0305\ A$.

Insert B in Eq. 4 on page 67. The equation should read $G = 0.157\ B + 0.495$.

Paper on Application of the Radioactive Tracer Technique to Metal Cleaning

In this paper by J. C. Harris, R. E. Kamp, and W. H. Yanko published in the ASTM Bulletin, No. 185, May, 1949, pages 49–52, the authors have indicated that the following corrections should be made:

Page 50, column 3, next to last line, page 51, column 1, lines 16 and 44, and page 52, column 1, fourth line from bottom, the expression 2×10^{-9} should be 2×10^{-7}.

Page 51, column 1, line 16, mg. should be changed to g.

Page 51, column 1, line 20, the expression $\pm 1 \times 10^{-9}$ should be $\pm 1 \times 10^{-7}$.

Tenth Annual Water Conference

The Tenth Annual Water Conference of the Engineers' Society of Western Pennsylvania will be held in the Hotel William Penn, Pittsburgh, Pa., on October 17 to 19, 1949. A number of interesting papers by outstanding authorities are scheduled for presentation. Further details of the program can be procured by contacting the E.S.W.P. Headquarters at the William Penn Hotel in Pittsburgh.

A number of A.S.T.M. members are participating, either as authors of papers or as chairmen of various sessions. Included in this group are Max Hecht, who is Chairman of A.S.T.M. Committee D-19 on Industrial Water, M. D. Baker, F. R. Owens, and L. K. Herndon, D-19 Vice-Chairman, and others.

Calendar of Society Meetings

American Institute of Electrical Engineers—Pacific General Meeting, August 23–26, Fairmont Hotel, San Francisco, Calif.

Instrument Society of America—National Conference and Exhibit, September 12–16, Municipal Auditorium, St. Louis, Mo.

American Public Works Association—Public Works Congress, September 18–21, Municipal Auditorium, Kansas City, Mo.

American Chemical Society—116th National Meeting, September 18–23, Atlantic City, N. J.

American Society of Mechanicl Engineers—1949 Fall Meeting, September 28–30, Erie, Pa.

National Lubricating Grease Institute—Annual Meeting, October 3–5, Hotel Roosevelt, New Orleans, La.

American Association of State Highway Officials—October 10–14, Gunter Hotel, San Antonio, Texas.

American Society for Testing Materials—Pacific Area Meeting, October 10–14, Hotel Fairmont, San Francisco, Calif.

American Society for Metals—31st Annual National Metal Exposition and Congress, October 17–21, Cleveland Public Auditorium, Cleveland, Ohio.

National Institute of Governmental Purchasing—4th Annual Conference and Products Exhibit, October 23–26, Hotel Cleveland, Cleveland, Ohio.

National Paint, Varnish and Laquer Association—61st Annual Convention, October 31–November 2, Chalfonte-Haddon Hall, Atlantic City, N. J.

American Concrete Institute—Regional Meeting, November 3–4, Boston, Mass.

American Institute of Chemical Engineers–Annual Meeting, November 7–10, Pittsburgh, Pa.

American Society of Mechanical Engineers—1949 Annual Meeting, November 27–December 2, New York, N. Y.

American Society of Civil Engineers—Annual Meeting, January 17–19, 1950, New York, N. Y.

American Society for Testing Materials—Committee Week and Spring Meeting, Hotel William Penn, February 27–March 3, 1950, Pittsburgh, Pa.

American Society for Testing Materials—53rd Annual Meeting and 9th Exhibit of Testing Apparatus and Equipment, June 26–30, 1950, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

To the A.S.T.M. Committee on Membership, 1916 Race St., Philadelphia 3, Pa.

Gentlemen:

Please send information on membership to the company or individual indicated below.

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This company (or individual) interested in the following subjects: (indicate field of activity, that is, petroleum, steel, non-ferrous, etc.,)

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Signed ____________________

Date________________ **Address**____________________

Engineering Laminates

Edited by Albert G. H. Dietz

LAMINATED engineering materials are employed in increasing volume and in more and more diverse fields because (1) they combine the properties of their component parts to obtain composite properties which may be new or unique, or (2) they make it easier or less costly to obtain certain properties than is possible with "solid" materials.

Laminates of engineering significance form the subject matter of this book. This includes composites of essentially all one class of material such as wood or metal, composites of several widely different materials such as plastic or rubber and fabric, composites essentially the same density throughout, and composites of lightweight cores and denser stronger skins commonly referred to as sandwich structures.

Sandwich-type building and aircraft panels, laminated timber, plastics-based laminates, and plywood, together with the methods of molding these materials, are described. Clad steel, hard surfacing, aluminum clad, glass lined steel equipment, and sprayed metals are among the metallic laminates discussed. Also discussed are corrosion, chemical resistance, properties, and the characteristics of laminating adhesives. Tables are interspersed throughout the book to expedite reference and calculation.

It is interesting to note that a substantial cross-section of the standardization work of A.S.T.M. is directly connected with the field of engineering laminates due to the many individual materials used. A still closer tie-in is the proposed scope of work of the newly formed Committee C-19 on Structural Sandwich Constructions of which Dr. Dietz, the editor of this book, is the chairman.

This 306-page, 6 by 9-in. book is published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., and sells at $10 per copy.

Laboratory Tests on Asphalt and Asphaltic Mixtures

A VERY concise and useful manual has been prepared by the Institute of Transportation and Traffic Engineering, University of California, for class use, on Laboratory Tests on Asphalt and Asphaltic Mixtures. This manual should be of interest to the asphalt testing field in general, copies being available.

The authors, A. Olitt and B. A. Vallerga, have correlated and classified the many control tests on asphalts and asphaltic mixtures in order to present a ready reference on test procedures. Many of the test procedures are from A.S.T.M. standards, along with those of A.A.S.H.O., California Division of Highways, Asphalt Institute, Shell Development Co., and in some instances from unpublished sources.

This manual can be obtained from the University of California Press, Berkeley and Los Angeles, Calif., at $1.65 per copy. It is identified as University of California Syllabus Series No. 312.

A.S.T.M. Metodos Normalizados de Ensayo y Analisis de Productos Derivados del Petroleo y Substancias Bituminosas

To the A.S.T.M. current, or former, students of Spanish the above title will indicate "A.S.T.M. Standard Methods of Testing and Analysis of Products Derived from Petroleum and Bituminous Substances." This is the title of an extensive new compilation issued in Argentina by Direccion General de Yacimientos Petroliferos Fiscales. Some time ago YPF contacted the Society indicating that a very useful purpose would be served if many of the A.S.T.M. standards covering petroleum, asphalts, and such materials could be translated into Spanish, and this new 540-page volume is the result of a great deal of work which began in 1946.

All told, there are 81 A.S.T.M. test methods included, all these being in line with the A.S.T.M. requirements through 1947. All of the measurements and such data where required in the methods have been expressed in the metric system.

Those who wish further information about this publication may write to the YPF, Casilla de Correo 1293, Buenos Aires, Argentina. It is of interest to note that this organization holds several memberships in the Society.

For those members who would be interested in how the following phrase from A.S.T.M. Methods D 71 would appear in English and Spanish, the translation is given—

The balance shall first be tared with a piece of fine waxed silk thread sufficiently long to reach from the hook on one of the pan supports to the straddle or rest.

Sp. La balanza se tarará primeramente con un hilo de seda recubierto de parafina, suficientemente largo como para alcanzar desde el gancho sosten de uno de los platillos de la balanza hasta el soporte.

Standard Samples Issued or in Preparation by the National Bureau of Standards

AN UP-TO-DATE list of standard samples issued or in preparation by the National Bureau of Standards is now available from the Bureau's Publication Section. The Bureau now issues more than 400 different kinds of standard samples, comprising materials of certified composition such as metals, ores, and ceramics; high-purity hydrocarbons; certain high-purity chemicals; paint pigments for color; oils for viscometer calibration; melting-point standards; radioactive materials; and a number of reference standards, such as lamp, opacity, and reflectance standards.

These standards have been established during the past 40 years to meet the constantly increasing needs of industrial and research laboratories. Representative uses of the Bureau's standard samples include the checking of chemical and instrumental methods of analysis; developing new methods of analysis; calibration of spectrometers, spectrographs, pH meters, calorimeters, pyrometers, and polarimeters; establishment of uniformity in test methods; and settling and avoiding of disputes between buyers and sellers.

Supplement to National Bureau of Standards Circular 398, *Standard Samples Issued or in Preparation by the National Bureau of Standards:* 19 large-sized pages; containing a schedule of fees, unit weight, directions for ordering, and other information; can be obtained free upon request from the Publications Section, National Bureau of Standards, Washington 25, D. C.

1949 Heating, Ventilating, Air Conditioning Guide

THE 1949 Heating Ventilating Air Conditioning Guide is now available. This is the 27th edition of this very comprehensive aid to engineers and contractors, published by the American Society of Heating and Ventilating Engineers.

In this revision all chapters have been reviewed and many revised and expanded wherever current engineering practice or recent published data have indicated progress or change in the presentation of the subject. The Guide consists of two sections—the Technical Data Section which has been enlarged by 80 pages and the Catalog Data Section which provides information on the latest products of 249 manufacturers. New subjects in the Technical Data Section cover space heaters, design procedure for large mechanical warm air systems and dust collectors.

This volume can be obtained from the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York 10, N. Y., priced at $7.50 per copy

Employment—Technical Services Available

Chemical Engineer, formerly associated with a textile printing company in the production department. Has a B.Ch.E. degree. Age, 24 years. Box 1, July, ASTM BULLETIN.

"COME, COME, GENTLEMEN! TWO HOURS SHOT — DOES THE COMMA STAY IN OR NOT?"

New Members to June 27, 1949

The following 119 members were elected from April 25, 1949, to June 27, 1949, making total membership 6661.

Names are arranged alphabetically—company members first, then individuals.

Chicago District

Chicago Vitreous Enamel Product Co., E. P. Bolin, Technical Supervisor, Frit Production, 1407 S. Fifty-fifth Court, Cicero 50, Ill.
Daylite Vacuum Products Co., John J. Purmal, Partner, 5207–09 Milwaukee Ave., Chicago 30, Ill.
Insulation Manufacturers Corp., A. S. Gray, Vice-President, 565 W. Washington Blvd., Chicago 6, Ill.
Bennett, Dwight G., Special Research Professor of Ceramic Engineering, University of Illinois, 204 Ceramics Bldg., Urbana, Ill.
Boardman, Harry C., Director of Research, Chicago Bridge and Iron Co., 1305 W. 105th, Chicago 43, Ill. For mail: 10357 S. Hoyne Ave., Chicago 43, Ill.
Campbell, G. E., Manufacturing Consultant, Borg-Warner Corp., 310 S. Michigan, Chicago 4, Ill.
Havens, Louis A., Assistant Director of Research, Lloyd A. Fry Roofing Co., 5818 Archer Rd., Summit, Ill.
Hume, Robert, Captain; Post Engineer, 0218083, Corps of Engineers, U. S. Department of the Army, Savanna Ordnance Depot, Savanna, Ill.
Leedy, Haldon A., Director, Armour Research Foundation of Illinois Institute of Technology, 35 W. Thirty-third St., Chicago 16, Ill.
Lutz, Raymond P., Assistant Superintendent of Manufacturing Engineering, Western Electric Co., Inc., Hawthorne Station, Chicago 23, Ill.
Palmer, Ralph M., Construction Engineer, City of Duluth, City Engineering Dept., 211 City Hall, Duluth, Minn.
Redmerski, Edmund S., Chief Engineer, American Hair and Felt Co., 1828 Merchandise Mart, Chicago 54, Ill.
Scripture, C. P., Vice-President, Ingram-Richardson Manufacturing Co., Frankfort, Ind.

Cleveland District

Erikson, G. L., Executive Vice-President, Braden Sutphin Ink Co., 3800 Chester Ave., Cleveland 14, Ohio.
Ford, Curry E., Assistant Manager, Chemical and Metallurgical Dept., National Carbon Co., Inc., Box 6087, Cleveland 1, Ohio.
Frahme, Herman H., Manager of Engineering, U. S. Stoneware Co., Akron 9, Ohio. For mail: 114 Winston Rd., Akron 13, Ohio.
Smith, William P., Sales Engineer, Baldwin Locomotive Works, Eddystone, Pa. For mail: 2507 Terminal Tower, Cleveland 13, Ohio.
Waltermire, William Glen, Chief Products Engineer, Lamson & Sessions Co., 1971 W. Eighty-fifth St., Cleveland, Ohio.

Detroit District

BullDog Electric Products Co., Elwood T. Platz, Director of Electrical Lab., Box 177, Detroit 32, Mich.
General Foundry and Manufacturing Co., O. E. Sundstedt, Vice-President and General Manager, Box 119, Flint, Mich.
Badaluco, J. A., Chief Engineer, J. C. Miller Co., 55 Mt. Vernon, N. W., Grand Rapids 4, Mich.
Couch, Albert H., Ceramic Engineer, Libbey-Owens-Ford Glass Co., 1701 E. Broadway, Toledo 5, Ohio.
Hangosky, C. W., Chief Metallurgist, Reo Motors, Inc., 1331 S. Washington Ave., Lansing 20, Mich.
Kalon, George, Chief, Materials and Process Section, Detroit Arsenal, Center Line, Mich.
Michigan College of Mining and Technology, Sault Ste. Marie Branch, Library, Sault Ste. Marie, Mich.
Pearce, Charles A., Laboratory Supervisor, Chrysler Corp., 12800 Oakland Ave., Detroit, Mich. For mail: 1122 Hoffman, Royal Oak, Mich.

New England District

Chemical Corp., K. P. Bellinger, Vice-President, 54 Waltham Ave., Springfield, Mass.
Brown, Arthur L., Chief Engineer and Assistant Manager, Associated Factory Mutual Fire Insurance Cos., 184 High St., Boston 10, Mass. For mail: 49 Hemenway St., Boston 15, Mass.
Burr, George S., Vice-President, Instron Engineering Corp., 2 Hancock St., Quincy 71, Mass.
Hindman, Harold, President, Instron Engineering Corp., 2 Hancock St., Quincy, Mass.
Sheehan, Thomas W., City Engineer, Engineering Dept., City of Malden, City Hall, Malden 48, Mass.

New York District

American Acoustics, Inc., John F. Conroy III, President, 74 Trinity Pl., New York 6, N. Y.
Arace and Sons, Inc., August, William Caddle, Jr., Assistant Secretary, 642 Third Ave., Elizabeth 4, N. J.
Federal Telecommunication Laboratories, Inc., A. J. Warner, Director of Research, 500 Washington Ave., Nutley 10, N. J.
York Research Laboratories, Edwin B. Michaels, Director of Labs., Box 1374, Stamford, Conn.
Beeman, Donald R., Assistant Chief, Mechanical Branch, Picatinny Arsenal, Dover, N. J. For mail: 49 E. Dewey Ave., Wharton, N. J.
Bonwitt, Wilhelm F., Quality and Research Engineer, Burndy Engineering Co., Inc., 107 Bruckner Blvd., New York 54, N. Y.
Clarkeson, John, Chief, Design Section, U. S. Public Roads Administration, 112 State St., Albany, N. Y. For mail: 41 Ten Eyck Ave., Albany, N. Y.
Clayton, Weaver R., Research Chemist, William Zinsser and Co., 516 W. Fifty-ninth St., New York 19, N. Y.
Foster, F. Gordon, Member of Technical Staff, Bell Telephone Laboratories, Inc., 463 West St., New York 14, N. Y.
Galassi, Michael, Factory Manager, William Zinsser and Co., 516 W. Fifty-ninth St., New York 19, N. Y.
Greer, Edward M., President and Chief Engineer, Greer Hydraulics, Inc., 454 Eighteenth St., Brooklyn 15, N. Y.
Hinek, Erma A., Supervisor, In Charge of Technical Files, Consumers' Research, Inc., Washington, N. J.
Holleran, Leslie G., Partner, Clarke, Rapuano & Holleran, 145 E. Thirty-second St., New York 16, N. Y.
Matthews, Thomas, Director of Laboratory, Atlas Supply Co., Newark, N. J. For mail: 22 Irving Pl., New York 3, N. Y.
Plansoen, John L., Supervisor, Plastic Dept., Federal Leather Co., 681 Main St., Belleville, N. J.
Powell, R., Supervisor of Processing, The Texas Company, 135 E. Forty-second St., New York 17, N. Y.
Ramsay, Edith, Home Equipment Editor, American Home Magazine Corp., 444 Madison Ave., New York 22, N. Y.
Schneider, John J., City Engineer, City of Passaic, Passaic, N. J. For mail: 555 Paulison Ave., Passaic, N. J.
Sprague, B. Sheldon, Research Physicist, Celanese Corporation of America, Central Research Lab., Summit, N. J.
Standen, Anthony, Assistant Editor, *Interscience Encyclopedia*, 99 Livingston St., Brooklyn 2, N. Y.

Northern California District

Fairbairn, E. A., Assistant City Engineer, City of Sacramento, Room 207, City Hall, Sacramento, Calif. For mail: 874 Fifty-sixth St., Sacramento 16, Calif.
Hanson, L. W., Chief Engineer, Calco Div., Armco Drainage and Metal Products, Inc., Seventh and Parker Sts., Berkeley 10, Calif.

Ohio Valley District

(In course of Organization)

Aldous, William M., Chief Construction Engineer, Development Section, Civil Aeronautics Administration, Technical Development Div., Indianapolis, Ind. For mail: 402 E. Main, Plainfield, Ind.
Alexander, J. B., Chemical Engineer, Southwestern Portland Cement Co., Osborn, Ohio.
Gelb, Amiel, Director of Laboratories, Stewart-Warner Corp., Southwind Div., 1514 Drover St., Indianapolis 7, Ind.
Getz, Delmond L., Chief Engineer, The Steel Products Engineering Co., Springfield, Ohio.
Kauer, T. J., Director, Ohio Highway Dept., State Office Bldg., Columbus, Ohio. For mail: 2041 Beverly Rd., Columbus 12, Ohio.

Philadelphia District

Pennsylvania-Dixie Cement Corp., P. O. Drawer 152, Nazareth, Pa. [S]†
Dalrymple, M. W., Assistant Metallurgical Engineer, Bethlehem Steel Co., Bethlehem, Pa.
Fair, W. D., Assistant Steam Engineer, Gulf Oil Corp., Philadelphia Refinery, Philadelphia, Pa. For mail: 16 N. Linden Ave., Alden, Pa.
Farber, J. D., Owner, Briggs Bituminous Composition Co., 1347–53 E. Montgomery Ave., Philadelphia 25, Pa.
Irwin, Harry F., Consulting Engineer, 1505 Race St., Room 719, Philadelphia 2, Pa.
Philadelphia, City of, Department of Supplies and Purchases, P. J. Mooney, Assistant Director, 302 City Hall Annex, Philadelphia 7, Pa.
Redstreake, Edward M., Sales Manager, Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa. For mail: 1095 Tyson Ave., Roslyn, Pa.
Reynolds, Edward A., Director of Quality, Dixie Cup Co., Easton, Pa.

Pittsburgh District

Davey, Wheeler P., The Pennsylvania State College, Department of Physics, Room 6, Osmond Lab., State College, Pa.
Kerr, Arthur J., Vice-President, Rockwell Manufacturing Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

St. Louis District

Moloney Electric Co., Edward H. Harvey, Jr., Chief Chemist, 5930 Bircher Blvd., St. Louis 20, Mo.
Meinholtz, Edward C., Engineer of Tests, Missouri Pacific Lines, 3001 Chouteau Ave., St. Louis 3, Mo.
Thomas, David, Assistant to President and General Manager, Fort Scott Hydraulic Cement Co., Box 267, Fort Scott, Kans.
Zuidema, H. H., Research Chemist, Shell Oil Co., Inc., Wood River, Ill.

Southern California District

California State Department of Public Works, Division of Architecture, C. W. Rhodes, 403 State Bldg., Los Angeles, Calif.
Helsley, J. T., Chief Testing Engineer, Reliance Engineers, Inc., 4215 E. Bandini Blvd., Los Angeles 23, Calif.
Hornkohl, Frank, Owner-Manager, Hornkohl Labs., Box 1673, Bakersfield 1, Calif.

Washington (D. C.) District

AXILROD, BENJAMIN M., Physicist, National Bureau of Standards, Washington 25, D. C.
DAVIS, ROBERT LOWELL, Chief Engineer, Robert L. Davis Co., 213½ Prince St., Beckley, W.Va.
KIRK, HARRY J., Manager, Department of Research and Safety, Associated General Contractors of America, Inc., 1227 Munsey Bldg., Washington 4, D. C.
KRAFFT, J. M., Executive, Krafft-Murphy Co., 2539 Pennsylvania Ave., N. W., Washington 7, D. C.

Western New York-Ontario District

CORNELL UNIVERSITY, D. F. Gunder, Professor of Materials, Ithaca, N. Y.
MASON, JACK H., Owner, Universal Metal Welding Co., 2260-68 Bailey Ave., Buffalo 11, N. Y.

U. S. and Possessions

NELSON ELECTRIC MANUFACTURING CO., N. J. Stowell, Research and Development Engineer, 217 N. Detroit, Tulsa 3, Okla.
PORTLAND GAS AND COKE CO., W. A. Kohlhoff, Superintendent, Production Bureau, Public Service Bldg., Portland 4, Ore.
SOUTHERN ELECTRICAL CORP., A. H. Tessmann, Vice-President, Box 989, Chattanooga 1, Tenn.
ASTORIA, CITY OF, G. T. McClean, City Engineer, City Hall, Astoria, Ore.
CAMPBELL, D. W., Testing Engineer, Trinity Testing Laboratories, Inc., Box 2376, San Antonio, Tex.
FOSS, HAROLD B., Architect, Foss & Malcolm, Architects, Box 2623, Juneau, Alaska.
HEATH, FRED, Secretary and Executive Director, Mason Material Dealers Assn., 818 Dermon Bldg., Memphis 3, Tenn.
HERBERT, JOHN S., President, W. G. Bush and Co., 174 Third Ave., N., Nashville 3, Tenn.
KEMLER, E. N., Associate Director, Southwest Research Inst., 312 Oil and Gas Bldg., Houston 2, Tex.
KOULAS, WILLIAM GUS, Project Engineer, Los Alamos Project, University of New Mexico, Albuquerque, N. Mex. For mail: 501 S. Vassar, Apt. D, Albuquerque, N. Mex.
RAWSON, R. H., Consulting Timber Engineer, 1206 Yeon Bldg., Portland 4, Ore.
SOUTHERN METHODIST UNIVERSITY, FONDREN LIBRARY, Dallas, Tex.
STATE A. & M. COLLEGE, J. Irwin Washington, Business Manager, Orangeburg, S. C.
WEST, ROBERT R., General Laboratory Chemist, Utah-Idaho Sugar Co., Salt Lake City, Utah. For mail: 1143 Douglas St., Salt Lake City, Utah. [J]*
WINGERTER, GEORGE E., President, Wingerter Laboratories, Inc., 660 N. W. Seventy-first St., Miami 38, Fla.

Other than U. S. Possessions

BRITISH RAYON RESEARCH ASSN., THE, Bridgewater House, 58 Whitworth St., Manchester 1, England.
BRITISH TYRE AND RUBBER CO., LTD., W. Bowden, Herga House, Vincent Square, London, S. W. 1, England.
INTERNATIONAL COMBUSTION, LTD., E. P. B. Wilson, Chief Chemist, Sinfin Lane, Derby, England.
STADLER, HURTER AND CO., Alfred Theodore Hurter, Partner, 1117 St. Catherine St., W., Montreal, P. Q., Canada.
ANDRE, POL, Chemical Engineer, 4 rue Leopold II, Mons, Belgium. [J]
BERAN, JAROSLAV K., Assistant Professor, University of Prague, Faculty of Civil Engineering, Karlovo-Nam 17, Prague 2, Czechoslovakia.
BRABER, PIETER, Director of Laboratory, Netherlands Indies Government Laboratory for Testing Materials, Hogeschoolweg, Bandoeng, Java, Netherlands East Indies.
CATEDRA "C" DE LA ESCUELA DE ARQUITECTURA, Jose Roberto Chomat Beguerie, Professor, Universidad de La Habana, Havana, Cuba.
DEFOE, ALBERT A., Chief Engineer, Electrical Conductor Div., Aluminum Laboratories, Ltd., 1800 Sun Life Bldg., Montreal 2, P. Q., Canada.
DUPUIS, ANDRE, Chemist, 1 rue de la Bruhaute, Jumet, Belgium. [J]
ECOLE ROYALE MILITAIRE, Laboratoire d'Essais des Materiaux, 30 Avenue de la Renaissance, Brussels, Belgium.
GEE, GEOFFREY, Director of Research, British Rubber Producers' Research Assn., 48 Tewin Rd., Welwyn Garden City, Herts, England.
GUYER, PAUL B., Chief Metallurgist, Cia Siderurgica Nacional, Rua 105, 64 Casa, Volta Redonda, Brazil.
HEYSTEK, HENDRIK, Research Officer, Council for Scientific and Industrial Research, Visagie St., Pretoria, South Africa. For mail: 15 Betty St., Riviera, Pretoria, South Africa. [J]
HOWARD, GILES P. E., Works Manager and Director, Hayward-Tyler and Co., Ltd., Luton, Beds., England.
INSTITUT BELGE DE NORMALISATION, Rue Des Deux-Eglises 17, Brussels 4, Belgium.
INSTITUTO TECNOLOGICO DE GUADALAJARA, Ciudad Universitaria, Guadalajara, Mexico.
LORING, HAROLD C., President, The Harold C. Loring Associates, Ltd., Chester, Nova Scotia, Canada.
NATIONAL ASSOCIATION OF TESTING AUTHORITIES, R. V. F. Eldridge, Registrar, National Standards Lab., University of Sydney, Sydney, Australia.
SIMPSON, ALLEN THOMAS, Sales Engineer, James J. Niven and Co., Ltd., Box 685, Dunedin, New Zealand.
SPENCER, EDWARD DUGDALE, Chief Engineer, Taylor Tunnicliff and Co., Ltd., Eastwood, Hanley, Staffs., England.
SYDNEY TECHNICAL COLLEGE, Librarian, Harris St., Ulrimo, Sydney, New South Wales, Australia.
TRAVNIK, ARNOST, Director, Drevarsky vyskumny ustav (Forest Products Laboratory), 10 Kramerov lom., Bratislava, Lamacska cesta, Czechoslovakia.
VARGAS, EDWARD ROMERO, Engineer, Monte Athos No. 184, Lomas de Chap, Mexico, D. F., Mexico.

*[J] denotes Junior Member.
†[S] denotes Sustaining Member.

PERSONALS • • •

News items concerning the activities of our members will be welcomed for inclusion in the column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

Antonio Albert, formerly Associate Professor, is now Professor and Head of the Department of Civil Engineering, University of the Philippines. Until recently located in Manila, the University is now at its new site, Diliman, Quezon City.

Three active A.S.T.M. members were recipients (jointly with other authors) of the annual **American Concrete Institute Awards. Frank H. Jackson,** Principal Engineer of Tests, Public Works Administration, Washington, D. C. (with Harold Allen), received the Wason Medal for the "most meritorious paper"—"Concrete Pavements on the German Autobahn." **R. C. Mielenz,** Head, Petrographic Laboratory, U. S. Bureau of Reclamation, Denver, Colo. (with K. T. Greene and E. J. Benton), received the Wason Award for "noteworthy research" for their work reported in their paper "Chemical Test for Reactivity of Aggregates with Cement Alkalies." **R. E. Davis,** Professor of Civil Engineering, University of California, Berkeley (with E. C. Jansen and W. T. Neilands), received the A.C.I. Construction Practice Award for the work reported in their paper "Restoration of Barker Dam."

The American Foundrymen's Society at its recent Annual Meeting in May honored the following A.S.T.M. members for noteworthy contributions to the arts and sciences pertaining to the development and production of cast metals. **Russell J. Anderson,** Works Manager, Belle City Malleable Iron Co., Racine, Wis., received the Peter L. Simpson Gold Medal for outstanding service as Chairman of the Wisconsin Chapter and of the Wisconsin Centennial Foundry Committee. **S. C. Massari,** Technical Director, AFS, received the John H. Whiting Gold Medal for outstanding contributions in the field of ferrous metallurgy, molding and foundry practice and service to the wartime foundry industry with the Chicago Ordnance District. **Gosta Vennerholm** was awarded the Wm. H. McFadden Gold Medal for outstanding contributions in the field of ferrous metallurgy and practice. **W. B. Wallis,** President, Pittsburgh Lectromelt Furnace Corp., was awarded Honorary Life Membership in the Society upon completion of his term as President of the organization, during which period he had visited each of the 40 chapters and seven student chapters, and maintained close contact generally with the entire membership.

Peter T. Bachinger has completed a Graduate Course at the School of Textiles, North Carolina State College, Raleigh, and is now associated with Stoffel & Co., Mels (St. Gallen), Switzerland.

J. Frank Barton, for the last 18 years Chief Chemist and Research Engineer of Federal Portland Cement Co., Buffalo, has resigned to enter the merchandising field with the Household Art Co., Hornell, N. Y.

H. D. Baylor, President, Louisville Cement Corp., was among several employees of his company who recently re-

ceived gold watches in recognition of 50 years of continuous service.

Charles W. Blacketer has been appointed to the new post of Manager of Customer Service for the Stamford, Conn., Branch of the Atlas Powder Co.'s Industrial Finishes Dept. Mr. Blacketer was formerly Chief Chemist for Berry Brothers in Detroit, and had previously been with the Sherwin-Williams Development and Research Laboratories in Chicago. He had also been engaged in promotional sales activities with the Diamond Alkali Co. in Painesville, Ohio.

Alfred R. Bobrowsky, formerly with the Heat-Resisting Alloys Research Section, Aircraft Engine Research Lab., National Advisory Committee for Aeronautics, Cleveland, Ohio, is pursuing further studies at the University of Michigan, Willow Run, Mich.

R. D. Bonney, Asst. Manager of Manufacturing, Congoleum-Nairn, Inc., Kearny, N. J., has been slated as President-elect of the Federation of Paint and Varnish Production Clubs. Mr. Bonney is one of the newly elected members of the A.S.T.M. Board of Directors.

Harold C. R. Carlson, President of the Carlson Co., Design Consultants, New York City, and **O. B. J. Fraser,** Asst. Manager, Development and Research Div., International Nickel Co., New York City, have been elected directors of the Technical Societies Council of New York, Inc., Mr. Carlson representing the American Society of Mechanical Engineers, and Mr. Fraser the American Institute of Mining and Metallurgical Engineers.

The Commercial Solvents Corp., New York City, has announced the appointment of T. S. Carswell as Vice-President in Charge of Research and Development.

Milford H. Corbin, formerly Vice-President and Director of Sales, Standard Varnish Works of New York, has been elected President of his company.

Richard S. Cox, Dean of The Philadelphia Textile Institute, was recently honored at a dinner marking the fiftieth year of his association with the Institute.

Arthur E. Cozens, formerly Materials Engineer, U. S. Corps of Engineers, South Pacific Testing Labs., Los Angeles, Calif., has been transferred to the U. S. Marine Air Station, El Toro, Calif., where he is serving in a similar capacity.

Axel Ekwall has been named Technical Adviser, Swedish Academy of Engineering Sciences, New York City. He was formerly connected with the Royal Swedish Embassy in U.S.A., in New York City.

Hugh Field has been elected Vice-President of The Atlantic Refining Co.

Royal E. Fowle, formerly associated with Pacific Coast Aggregates, San Francisco, is now Consulting Engineer, Fowle & Davis, Los Altos, Calif.

Franklin H. Fowler, Jr., has accepted appointment as Associate Editor, McGraw-Hill Publishing Co., New York City. He was previously Project Engineer, Lessells & Associates, Boston, Mass.

I. Leon Glassgold is now President of Masonry Resurfacing and Construction Co., Inc., Curtis Bay, Md.

Bruce W. Gonser, Supervisor, Non-Ferrous Research, Battelle Memorial Institute, Columbus, Ohio, and **Charles E. MacQuigg,** Dean of College of Engineering, Ohio State University, Columbus, are among the trustees of the newly formed Tin Research Institute which has now been set up as an American corporation at 492 West Sixth Ave., Columbus.

H. J. Gough was recently elected President of The Institution of Mechanical Engineers of Great Britain. An expert on the problem of fatigue in metals, Dr. Gough is well known among scientists and professional engineers. He has lectured before leading technical societies and colleges in England and the United States, and has contributed greatly to the field of scientific literature. In 1942 he was appointed Director General of Scientific Research and Development of the Ministry of Supply. Since September, 1945, he has been Engineer-in-Chief of Lever Brothers & Unilever, Ltd., London.

William H. Graves, Executive Engineer, Packard Motor Car Co., Detroit, has been elected Vice-President and Director of Engineering.

E. W. Greenfield, Supervisor, Electrical Laboratory, Anaconda Wire and Cable Co., Hastings-on-Hudson, N. Y., has been elected Vice-Chairman of the Conference on Electrical Insulation, Division of Engineering and Industrial Research, National Council Research, for the term 1949–1950.

John Howe Hall, Metallurgist, General Steel Castings Corp., Eddystone, Pa., delivered the Annual Lecture at the American Foundrymen's Society's 53rd Annual Meeting in St. Louis in May, his subject being "Steel Castings in Welded Assemblies." The first recipient of the Society's John H. Whiting Gold Medal, in 1924, for "outstanding contributions to the steel casting industry," Mr. Hall has a distinguished record in this field. Among his pioneering achievements in the field of steel metallurgy are the use of intermediate manganese steel in castings, introduction of the practice of quenching and reheating of alloy steel castings, development of a welding rod for manganese steel, melting of ferro-manganese in the cupola, first successful use of an electric furnace for the melting of manganese steel, and the remelting of manganese steel scrap in an electric furnace. Active in many technical societies and widely known as an author and speaker, Mr. Howe has rendered service on many A.S.T.M. technical committees throughout the years. His membership dates from 1910.

John H. Harley, formerly Instructor, Rensselaer Polytechnic Inst., Troy, N. Y., is now Chief, Chemistry Lab., Medical Div., U. S. Atomic Energy Commission, New York City.

William Harrower, formerly Chief Engineer, has been appointed President of Everlasting Valve Co., Jersey City, N. J.

Edgar Morton Hastings, Chief Engineer of the Richmond, Fredericksburg & Potomac Railroad, Richmond, Va., has been elected Honorary Member of the American Railway Engineering Association. A member of the A.R.E.A. since 1912, he has given able and enthusiastic support to measures that have advanced its standing and influence. Mr. Hastings has also taken an active part in the work of other groups. He has been affiliated with A.S.T.M. since 1927.

Giles E. Hopkins, formerly Division Sales Manager, R. T. Vanderbilt Co., Inc., New York City, has been named Technical Director of the Wool Bureau, Inc., of the same city. He will head the Department of Science and Technology which will conduct a broad scale research program with emphasis on studies of the wool fiber and the correlation and interpretation of laboratory research for the manufacturing elements of the wool textile industry. Mr. Hopkins has been active in technical societies in the textile and research field for many years. He is Vice-Chairman of A.S.T.M. Committee on Textile Materials, and organized and for six years was Chairman of its Subcommittee on Wool. He also served as a member of the Executive Committee of the Society.

W. S. James, formerly Specification Writer, Bennett & Bennett, Architects, Pasadena, Calif., is now Consultant, Altadena, Calif.

Charles Morris Johnson has retired as Director of Chemical Laboratory and Laboratory Ceramics Dept., Park Works, Crucible Steel Co. of America, Pittsburgh, Pa. Mr. Johnson has been affiliated with A.S.T.M. since 1918 and has been a member of Committee E-3 on Chemical Analysis of Metals for many years.

Frederick J. Kelly, formerly Chief Metallurgist, Eaton Manufacturing Co., Detroit, is now on the technical staff of the Carboloy Co., Inc., of the same city.

Charles F. Kettering, Director and Consultant, General Motors Corp., Detroit, Mich., was recently honored by the American Society of Lubricating Engineers by the awarding of a life membership in that group.

Ernest L. Korb, formerly with E. I. du Pont de Nemours and Co., Inc., Wilmington, Del., is now associated with The Pure Oil Co., Chicago, Ill.

F. L. LaQue, in Charge of Corrosion Eng. Section, Dev. and Research Div., The International Nickel Co., Inc., New York, received the 1949 Frank Newman Speller Award of the National Association of Corrosion Engineers, in recognition of achievement in the field of engineering.

Roger E. Marce, formerly Director of Laboratory, Neilson Chemical Co., Detroit, Mich., is now in business for himself, his present address being 14647 Cedargrove, Detroit.

Leonard Mayeron, formerly Materials Engineer, is now Chief of Materials Div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

R. B. Mears, Manager, Research Lab., Carnegie-Illinois Steel Corp., Pittsburgh, Pa., received the 1949 Willis Rodney Whitney Award of the National Association of Corrosion Engineers, in recognition of achievement in the field of corrosion science, presentation being made at the NACE Annual Banquet held in Cincinnati, Ohio, on April 13.

Robert F. Mehl, Director of the Metals Research Laboratory and Head of the Metallurgical Engineering Department at Carnegie Institute of Technology, Pittsburgh, Pa., has been spending several weeks in Brazil where he will be a guest at the 50th Anniversary of the Research Institute of the State of São Paulo, and will also attend the Fifth Anniversary of the Brazilian Society of Metals, which he helped organize. The recipient of an honorary doctor's degree from the University of São Paulo, Dr. Mehl is a permanent member of the faculty there. During his last visit to São Paulo, which is called the Pittsburgh of South America, he lectured to industrialists and students on American metallurgical knowledge and practices. During his present stay in South America he will also participate in the dedication of new laboratories at the Cidade Universitaria.

William Hayne Mills is now District Engineer, The Asphalt Institute, Atlanta, Ga. He was previously Chief, Airport Engineering & Construction Div., Civil Aeronautics Administration, Atlanta.

J. J. Morrisroe, formerly Manager, Technical Service, Oronite Chemical Co., San Francisco, Calif., is now Director of Research, Purex Corp., Ltd., South Gate, Calif.

Jules Muller is now Director of Engineering, E. W. Bliss Co., Toledo, Ohio.

John A. Munyak, formerly Chief Engineer, Polarized Products Corp., New York City, has been appointed to head the expanded Engineering and Technical Department of the Sillcocks-Miller Co., Maplewood, N. J.

Arpad Nadai, Consulting Mechanical Engineer for the Westinghouse Research Laboratories, East Pittsburgh, Pa., and internationally known specialist in the plastic flow of metals, has retired after more than 35 years of service in his field.

G. G. Oberfell, Vice-President in Charge of Research, Phillips Petroleum Co., Bartlesville, Okla., heads the Executive Committee of the Research Institute of the **University of Oklahoma.** A new building has now been finished for the Institute, set up in 1941, and its organization has been completed. A nonprofit corporation, chartered separately from the university but drawing its staff members from the university faculty, and its financial support from the university and from sponsored research, its broad purposes are " . . . to promote educational objectives by encouraging, fostering, and conducting scientific investigations and industrial and other types of research . . . . To provide, or assist in providing, the means and machinery by which scientific discoveries, inventions, and processes may be developed, applied, and patented . . . ." Fields to be covered by the Institute include business management, biology and agriculture, bibliographic service, chemistry, electron microscopy, engineering, geology and geography, mathematics, physics, psychology, and special instrument design and development.

The Philadelphia Textile Institute recently held ceremony for laying of the cornerstone for the new home of the Institute at 3243 School House Lane, Germantown, Pa., thus affording its many friends an opportunity to inspect the new building which is well on the way to completion.

Rolf T. Retz, formerly Civil Engineer and Estimator, Virginia Engineering Co., Inc., Newport News, Va., is now Contracts Engineer, California State Div. of Architecture, Sacramento, Calif.

Herbert R. Reynolds, after thirty-five years with the Interborough Rapid Transit Co. and its successor, the New York City Transit System, successively a Assistant Engineer, Mechanical Research Engineer, Mechanical Engineer, Superintendent of Motive Power of the IRT Division and Superintendent of Power Generation for the entire System, has retired from the System and has become associated with the J. G. White Engineering Corp. During his regime as Mechanical Engineer for the IRT he introduced improved operating methods which markedly reduced the cost of generating power.

W. E. Santoro has been made Director of Laboratories of Standard Varnish Works, New York City. He had been in charge of the company's metal decorating division.

Charles H. Scholer, Head of the Applied Mechanics Dept., Kansas State College, Manhattan, Kan., has received the distinguished service award from the Highway Research Division of the National Research Board, Washington, D. C. This is only the second such award made by the Board. Prof. Scholer pioneered studies on concrete durability, A.S.T.M. publishing as early as 1926 report of his study of accelerated freezing and thawing tests on concrete.

Sherrill Seeley, formerly Head Chemist, Skenandon Rayon Corp., Utica, N. Y., is now Chief Chemist, Beaunit Mills, Inc., Childersburg, Ala.

Victor Siegfried, Chief Research Engineer, American Steel and Wire Co., Electrical Cable Works, Worcester, Mass., continues as a member of the Board of Directors of the American Institute of Electrical Engineers for the next administrative year.

Erwin Sohn, formerly Director of Research, American Radiator and Standard Sanitary Corp., Louisville, is now associated with the National Sanitary Co., Salem, Ohio.

Alexander C. Speer, previously Engineer, Arabian American Oil Co. (Saudi Arabia), is now Asst. District Engineer, Johns-Manville Corp., Houston, Texas.

Thomas D. Tifft, formerly Asst. Chief Engr., is now Chief Engr., Sinclair Refining Co., New York City.

Everett R. Turner, formerly Special Trainee, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ont., Canada, recently assumed the position of Melting Supt. with the Venezuelan Steel Corp. at Caracas, Venezuela. Mr. Turner expects to be in Venezuela for three years and will be in charge of the Venezuelan Steel Corp.'s laboratory and melting operations. This company anticipates starting producing electric furnace steel this summer.

John Van Brunt, Vice-President, Engineering, Combustion Engineering-Superheater, Inc., New York City, received the honorary degree of doctor of engineering from Stevens Institute of Technology, Hoboken.

David M. Williams is now Proprietor, The Foil Fab Co., Warrensville Heights, Ohio. He was previously Manager, Physical Testing Dept., The Arco Co., Cleveland, Ohio.

Lincoln T. Work, who has been with Metal & Thermit Corp., Rahway, N. J., as Director of Research and Development, has left that organization to become associated with **Alan R. Lukens,** Vice-President, Powdered Material Research Laboratory, Cambridge, Mass. The consulting practices of this organization have been backed by broad experimental activity, specializing in the measurement of particle size, surface area, and particle structure. Many years of experience have correlated this with the utility of extenders and pigments in paint, paper, rubber, plastics, and allied products. With the advent of Dr. Work, its field of utility will be widened to undertake work on abrasives, refractories, metal powders, cements, and dusts. Dr. Work is an authority on grinding, classification, and filtration. Prior to joining the Metal & Thermit Corp., Dr. Work was on the staff of the Chemical Engineering Department at Columbia University and at that time was well known in consultative engineering. Many will recognize him for his chairmanship of the Advisory Committee of A.S.T.M.'s Technical Committee III of E-1 on Particle Size and Shape, and for his chairmanship of A.C.S. symposia on grinding and fine particles at Brooklyn Polytechnic Institute in 1945, and on fluidization at Massachusetts Institute of Technology in 1948. Dr. Work has also been active for some years in the New York District Council of A.S.T.M., and in the work of Committees D-1 on Paint and E-12 on Appearance. He has been a member of the Society since 1924.

NECROLOGY

F. D. Cronin, U. S. Department of Agriculture, Wool Division, Washington, D. C. Represented the Wool Division on Committee D-13 on Textile Materials since 1946.

M. K. Easley, Sales Engineer, American Zinc Oxide Co., Columbus, Ohio (April 22, 1949). Formerly representative of American Zinc, Lead & Smelting Co. on Committee A-5 on Corrosion of Iron and Steel. Member since 1941.

Henry W. Kimmel, Vice-President and Secretary, Taylor Instrument Companies, Rochester, N. Y. (May 26, 1949). Mr. Kimmel's 53 years of service with the Taylor organization brought him a wide range of friends all over the country, many of whom are counted among our A.S.T.M. members. At the time of his death, he was also President of the Taylor Instrument Companies of Canada Ltd., as well as a trustee of the Community Savings Bank, Rochester, and a Director of the Utica Mutual Life Insurance Co. The Taylor organization has been affiliated with A.S.T.M. in membership since 1940 and recently subscribed to the Sustaining Class.

Ray P. Mattern, Chief of Materials Div., General Engineering Dept., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. (April 18. 1949). Representative of company membership since 1947, also representative of his company on Committee B-4 on Electrical Heating, Resistance, and Related Alloys, and its Subcommittee X on Contact Materials since April, 1948.

Preston S. Millar, President, Electrical Testing Laboratories, Inc., New York City (June 17, 1949). Member since 1942. A leader in the field of illumination and President and Director of the Electrical Testing Laboratories since 1929, Mr. Millar died rather suddenly. He was a Past-President of the Illuminating Engineering Society and was extremely active in the American Council of Commercial Laboratories.

L. B. Miller, Professor, Department of Chemical Engineering, University of Cincinnati, Cincinnati, Ohio (April 29, 1949). Represented Technical Association of the Pulp & Paper Industry on Committee D-19 on Industrial Water and several subcommittees since 1940. Formerly, when affiliated with Keasbey & Mattison Co., Ambler, Pa., had been a member of Committee C-16 on Thermal Insulating Materials, and a consulting member of Committee C-8 on Refractories.

A. C. Nixon, Fisher Body Detroit Div., General Motors Corp., Detroit, Mich. (May 25, 1949). Representative of his company on Committee D-11 on Rubber and several subcommittees since 1941.

Floyd F. Oplinger, Manager of Electroplating Service and Development, E. I. du Pont de Nemours and Co., Inc., Grasselli Chemicals Dept., Wilmington, Del. (May 9, 1949). Representative of du Pont Grasselli Chemicals Dept. on Committee B-8 on Electrodeposited Metallic Coatings and several of its subcommittees since 1947.

A. G. Tainton, General Manager, Pretoria Portland Cement Co., Ltd., Johannesburg, South Africa. Representative of company membership since 1940.

James F. Wooten, American Steel & Wire Co., Worcester, Mass. Represented his company on Committee D-13 on Textile Materials since 1942.

Edward R. Young, Metallurgical Engineer, Climax Molybdenum Co., Chicago, Ill. (June 9, 1949). Member since 1933. In the death of Mr. Young the Society loses a member who had contributed a great deal to the advancement of different phases of its work. Active in Committee A-3 on Cast Iron for many years, he was the Secretary of this Committee for two terms, and was Chairman at the time of his death. He served on several subcommittees in Committee A-1 on Steel, particularly those concerned with castings and fittings, and was a former Chairman and a current member of the Chicago District Council. Another service to A.S.T.M. was representation of the Society on the American Foundrymen's Society, Gray Iron Division. Mr. Young (Ed, as he was known to most of his associates) was taken ill the early part of the year although he did get down to the A.S.T.M. Spring Meeting in Chicago, but shortly afterward he had an operation and it was subsequently learned that the ravages of cancer had gone so far that nothing could be done.

Notes on Laboratory Supplies

Catalogs and Literature; Notes on New or Improved Apparatus

This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

Catalogs and Literature

The Baldwin Locomotive Works, Testing Equipment Department, Philadelphia 42, Pa. A new two-page illustrated leaflet, Bulletin 274, describes the applications of SR-4 Load Beams, such as for process and machine control, and for general force measurement. The beams are sensitive and accurate force measuring cantilevers on which SR-4 bonded resistance wire strain gages serve as force measuring elements for a wide range of loads.

Also, a new twelve-page Bulletin, No. 261-A, describes the supplementary devices which are used to adapt testing machines to the widest scope of testing conditions. These include several types of specimen grips, auxiliary equipment to widen the range of testing, such as transverse test fixtures, cold bending fixtures, and load-weighing air cells; accessories that extend some aspect of testing machine performance, such as the controlled-temperature cabinet, funace and load controlling accessories; and various testing conveniences. More than 30 illustrations show this equipment and how it is used.

Bausch & Lomb Optical Co., Rochester 2, N. Y. Catalog D-104 entitled "Phase Contrast Accessories" gives a rather complete explanation of the Phase Contrast Method, gives practical applications of phase contrast, and lists Bausch & Lomb Phase Contrast Accessories such as the Turret-type Abbe Condenser, Individual Annular Stop Type L.W.D. Condenser, Illuminators, Replacements, Stands, etc. 16 pages, 8½ by 11 in., illustrated.

Burrell Technical Supply Co., 1942 Fifth Ave., Pittsburgh 19, Pa. Bulletin No. 315 entitled "Burrell Unit-Package Box and Muffle Furnaces" describes these furnaces for low- and high-temperature operation. Five different models are available for analysis, control and production in chemistry, metallurgy and manufacturing. Four pages, illustrated.

Also, Bulletin No. 515 entitled "Burrell High Temperature Electric Furnace," Model LGM, four pages. Illustrated.

The Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill. Bulletin 171-49 entitled "Gaertner Chronographs and Time-Standards" describes and illustrates tape chronographs, drum chronographs, accessories for chronographs, electrically controlled tuning forks regulator clocks, etc. 16 pages.

Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill. "Why,"—a new manual which presents a discussion on "Precision"—Freas Ovens, giving their features. Full information on incubators, ovens, and sterilizers is included. Copies of the "Why" Manual No. 397NR will be mailed on request.

Also, a new 32-page, two-color Catalog 860NR is now available from Precision illustrating and describing a complete line of laboratory apparatus and accessories for the preparation of metallographic specimens. Included are the "Polmatic" Automatic Polisher, the "Subcut" Submerged Specimen Cutter, the "Aeromount" Semi-Automatic Specimen Mounting Press, hand-operated Mounting Presses and Polishers, with many accessories.

Precision also announces the completion of their Petroleum Testing Apparatus Catalog No. 705NR. The new 104-page book contains test apparatus for asphalt, gas, gasoline, grease, and lubricants. In addition, a complete listing of petroleum testing utilities such as baths, combustion apparatus, distillation units, high-pressure equipment, samplers, and thermometers are included. Items are grouped by purpose and are indexed alphabetically as well as numerically.

E. H. Sargent & Co., 155–165 E. Superior St., Chicago 11, Ill. "Scientific Apparatus and Methods Including Latest

Catalog Revisions"—Spring, 1949. This 42-page catalog includes chapters on "Theory and Operation of the Manometric Blood Gas Apparatus" and "Radiant Heating of Organic Combustion Apparatus." Section Two covers scientific apparatus—new items, reinstated items, discontinued items, and changes in specifications. Among some of these are the new torsion balance, non-ferrous burette clamp, brass clamp holder, quartz tube combustion apparatus, gas drying unit, and others. Illustrated.

Taylor Instrument Cos., Rochester 1, N. Y. "Taylor Technology"—Spring, 1949, Issue—features articles on the new transaire temperature transmitter, world's largest belt press, continuous carbon disulfide purification process, and others. 28 pages, illustrated.

Will Corporation, Rochester 3, N. Y. Features of a new Bausch & Lomb Refractometer, the "Abbe 56," are described in Laboratory Equipment Bulletin No. 108. The bulletin also announces a new Universal Cell Holder for accommodation of various sizes of absorption cells as an accessory for the Kromatrol photoelectric filter photometer, and a new, small, self-contained autoclave sterilizer. 4 pages, illustrated. For copies write Will Corporation, Department STM.

Instrument Notes

New Universal Testing Machine (Model PTE)—The Baldwin Locomotive Works, Philadelphia 42, Pa. Hydraulic and pneumatic load cells are used as load-sensitive elements in the weighing system, both operating a Tate-Emery indicator. Four standard load ranges are provided by the hydraulic cell. These are 5000 lb., 1000 lb., 200 lb., and 50 lb. Two additional ranges of 10 lb. and 2 lb. are provided when specified, by means of an air cell. These machines are suitable for testing plastics, fine wire, light metal foils, light structures of wood, plastic, or metal; textile materials, fibers, cord, paper, and other materials.

Wood Testing Fixtures for Standard Testing Machines—The Baldwin Locomotive Works. Fixtures include those for the transverse or static bending test, tension parallel-to-grain, cleavage, hardness, compression perpendicular-to-grain, and shear parallel-to-grain. These fixtures are designed to meet the latest specifications of A.S.T.M. (D 143–48).

Microscope Attachment—Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y. This attachment provides three types of reflected illumination—bright field, dark field, and polarized. Known as the Tri-vert Illuminator, it can readily be attached to the body tube of any standard non-objective microscope for the examination of opaque or semi-opaque specimens. The change-over from dark field to bright field illumination is instantaneous and is controlled by a lever. A polaroid polarizer and cap analyzer provide for polarized light examinations. Designed to provide comparison studies under three types of illumination, the attachment, which in no way impairs the focusing of the microscope, is expected to have wide application in biological and metallurgical research, as well as in the plastics, textile, paint, ceramics, and other fields.

Coatingage—Branson Instruments, Inc., Stamford, Conn. This is an instrument for measuring the thickness of nonmagnetic coatings on iron or steel. Measurements are made rapidly, without damage to the coating, and the thickness is indicated directly on the meter of the instrument. Typical applications for the Coatingage include the measurement of the thickness of paints, enamels, metal plating, protective coatings, scale or coke deposits.

Baker Film Applicator—Henry A. Gardner Laboratory, Inc., 4723 Elm St., Bethesda, Md. A simple film applicator with adjustable clearance, dependable accuracy and ease of manipulation. It is also compact, being small enough to fit in a coat pocket. Use can be made of the applicator in routine film-forming operations, hiding power determinations, color intensity measurements, wrinkling studies, etc. The applicator consists essentially of: a cylindrical applicator section, end cylindrical bearing sections, axial shaft concentric with the applicator axis and extending beyond each end for mounting the end guide plates, end guide plates fitted on the axial concentric shaft, and lock nuts to lock assembly together.

Photometric Unit and ExposureHeads—Henry A. Gardner Laboratory, Inc. This apparatus consists of a sensitive electrical measurement device and a number of exposure heads. Each exposure head contains a light source, means for directing light onto test specimens, and one or more photocells that receive light from these specimens in a manner to indicate useful optical properties. To prepare for measurements of any such property, the appropriate exposure head is connected to the Photometric Unit by cable, a suitable standard is inerted at the exposure head, and standardizing adjustments are made. After this preparation, each specimen is inserted in turn and measured on the large dial of the Photometric Unit by finding the setting of this dial that causes a galvanometer spot to return to balance position. Where apparatus is needed to measure color and color difference in addition to another optical property, it is possible to use the measurement unit of the Color and Color-Difference Meter with the appropriate exposure head. Makers of paints, textiles, papers, plastics, ceramics, food products, and many other materials of commerce have similar problems in evaluating appearance which can be handled with speed and precision by this apparatus.

New Portable 75 deg. Glossmeter—Henry A. Gardner Laboratory, Inc. An inexpensive Glossmeter for testing paper and other materials, it consists of an exposure head with lamp, lens, and sensitive lightmeter. This new unit has been designed especially for the coated-paper, waxed-paper, and carton branches of the paper trade, but it should be useful in other fields also.

The Othmer Still for Accurate Determination of Vapor-Liquid Equilibrium—The Emil Greiner Co., 20-26 N. Moore St., New York 13, N. Y. For the design of equipment and the analysis of problems in the field of distillation and related unit operations, vapor-liquid equilibrium data are essential, and this still can be used to obtain these data. This Othmer Still is the latest development of Dr. D. F. Othmer of the Polytechnic Institute of Brooklyn. The operation of the still is based on the reflux equilibrium principle.

Lecotherm Combustion Boat—Laboratory Equipment Corp., St. Joseph, Mich. This is for carbon and sulfur analyses of iron and steel. Packaged in master cartons of one thousand, Lecotherm Combustion Boats arrive in the laboratory in individual contamination resistant packages of ten boats each, and they can be used directly from their individual packages without previous "burning off" to remove blank. The penetration resistance of these boats is one of their features.

Leco 2800 degree Furnace Model No. 100—Laboratory Equipment Corp. This furnace is designed to operate at 2800 F. The furnace is well insulated which means minimum heat loss. It is used for carbon and combustion sulfur analyses, especially where materials are difficult to combust, and where speed is desired.

Leco No. 4000 Semi-Automatic Carbon Determinator—Laboratory Equipment Corp. This Determinator eliminates hand operation of the leveling bottle which is necessary. With this Determinator the leveling bottle remains permanently in the base of the apparatus and all solutions are raised and lowered by oxygen pressure which is controlled by two needle valves. The final reading of the per cent carbon is obtained by raising the leveling solution in the burette by means of a needle valve until the height of the solution is the same as that in any auxiliary tube.

Leco No. 450 Precision Carbon Determinator—Laboratory Equipment Corp. This is designed for low percentages of carbon, and is used for checking heats that are near specification limits, checking inter-plant analyses, providing precise information regarding carbon content of experimental heats, and for analyzing samples in the low carbon range (below 0.10 per cent). Operation is simple, and very little maintenance is required.

Vertical Tube Sulfur Determination Apparatus—Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill. This apparatus was engineered to give a rapid method of sulfur determination for the petroleum and organic chemical industries. Multiple analysis of a variety of oils, paints intermediates, and other liquid organic compounds can be performed simultaneously. The Pyrex tube of older methods is replaced by a stainless steel tube. Sulfur determination in a greater variety of materials is possible with the steel tube.

Micro-Set Manostat—Precision Scientific Co. This is for regulating and holding a constant vacuum, its most intensive application being found in the petroleum, organic chemical, and similar industries for vacuum distillation. The apparatus is installed between a vacuum pump and a distillation system. It operates on a principle of controlled leaks to atmosphere. It has a control sensitivity of better than 0.05 mm. Hg and it operates from atmospheric to absolute vacuum.

10-Unit Warburg Apparatus—Precision Scientific Co. This has been developed for students and laboratories not requiring larger apparatus. Specific applications in biolgical laboratories are as follows: For measuring respiratory exchange in yeast, bacteria spores, plant and animal tissues, and for the measurment of lactic acid production by normal and tumor tissues;

for reactions in which acid or alkali is produced or consumed in bicarbonate solutions in equilibrium with CO_2 gas mixtures; and for the measurement of blood gases and investigating the reactions of hemoglobin and other blood pigments. The apparatus holds 10 Warburg manometers which can be read in motion or stopped in pairs by a seated operator.

"Precision" Shell Evaporometer—Precision Scientific Co. This was developed for the determination of evaporation rates of all solvents with a viscosity less than 100 cp. and the solvent release characteristics of resin solutions.

Constant Temperature Shaking Bath—Precision Scientific Co. This apparatus has a special value to biological laboratories for the shaking incubation of tissue, foods, and other cultures. It eliminates manual shaking and the inconveneince of improvising mechanical setups. The bath has a temperature range from room temperature to 70 C. with a control accuracy of 0.5 C. The rate of shaking with a full load can be varied from 0 to 192 strokes per minute with the maximum stroke and from 0 to 252 strokes.

Scientific and Industrial Counter—The Streeter-Amet Co., 4101 N. Ravenswood Ave., Chicago 13, Ill. This counter can be actuated by any electrical pulse or signal from a contact switch, photo tube and amplifier, metal detector, etc. It is made to register any change in electrical intensity. This allows it to be used in conjunction with an arc welder, drill press, or other power device. When the load changes beyond a certain point, a count is registered. The counters may be equipped to count the number of signals in a group; are used in conjunction with Geiger counters and scaling circuits, and are valuable in radioactive contaminated areas. They are also useful where background counts must be taken over a period of time.

New Type Testing Thermometers—Taylor Instrument Cos., Rochester, N. Y. These thermometers are specifically designed for measuring, sampling, and testing crude oil, but they will find ready use as general test thermometers. The new $16\frac{3}{4}$ in. Cup Case Thermometers (A.S.T.M. 58 F–48 T and 59 F–48 T) are manufactured in two ranges—minus 30 to plus 120 F. and 0 to 180 F. with a guaranteed accuracy of plus or minus $\frac{1}{2}$ F. Taylor Binoc tubing together with the large figures and clearly marked 1 deg. scale divisions make easy reading. The case is made of oak and specially treated to resist warping. The ample, 100-cc., nonsparking brass cup holds sufficient sample at the proper immersion of the thermometer tube to maintain the temperature while sampling is made. The Armored Thermometers are 12 in. long with the Binoc Etched Stem thermometer encased in nonsparking brass armor. Ranges: minus 30 to plus 120 F. and 0 to 180 F. (A.S.T.M. 58 F–48 T and 59 F–48 T).

Photoelasticity Polariscope—Techne (Cambridge) Ltd., Duxford, Cambridge, England. This instrument is used in solving problems of stress distribution in mechanical parts and structures. The polariscope is mounted on a strong base which can be fastened to the floor by fixing brackets. All the components of the instrument are borne by the precision bar which is rigidly fixed to the base and serves as an optical bench. The components can be moved, unhindered, the full length of the bar. In operation, a model of the structure to be examined is made from transparent material and placed in a straining frame. Here it is subjected to tension or compression proportional to that exerted on the original. The stress distribution is clearly shown by a series of light and dark, or colored, lines on the screen. These can be interpreted qualitatively or quantitatively either directly from the screen or from a photograph.

Techne Industrial Viscometer—Techne (Cambridge) Ltd. This instrument is used for rapidly finding the viscosity of thick, sticky liquids. Its characteristics are ease of cleaning and simplicity in use. The novelty of the instrument lies in the method of producing a known constant air pressure which forces the liquid under examination from a container into a horizontal glass capillary tube, open at its far end to the air. It is indicated that the viscometer is: easy to clean; gives the answer directly in poises; no leveling is necessary; small sample is needed, and operation can be learned quickly.

1500 Series Bench-Type TEMCO Electric Furnaces—Thermo Electric Manufacturing Co., Dubuque, Iowa. These completely equipped, but low-cost furnaces, are especially suited for laboratory work such as ashings, ignitions, fusions, process control, etc., and are also used for hardening and tempering small steel parts and tools. These furnaces employ the Thermo Temcometer stepless and wasteless temperature controller which is built into the instrument panel mounted in the base of the furnace.

New Tukon Microhardness Tester—Wilson Mechanical Instrument Co., Inc., 230 Park Ave., New York 17, N. Y. Model MO, a new Tukon Microhardness Tester, is mechanically operated, and is recommended for those interested in light load testing where there is not sufficient testing to warrant a fully automatic model. The MO is well designed, accurate, and easy to operate, and is made in both a floor and bench model. It applies loads of from 1 to 1000 g. and may be used with either the knoop or 136 deg. Diamond Pyramid Indenters. One of the features of this model is a special arrangement for removing the load without the operator having to touch instrument until indenter is out of impression.

News of Instrument Companies and Personnel

On April 17 E. H. Sargent & Co. broke ground at 4601–53 Foster Ave. in Chicago in preparation for the construction of a 130,000 square foot one-story building which will eventually house all of that company's Chicago operations. Warehouse, shipping, and receiving sections will be equipped with the latest types of conveyor systems to speed up the filling of orders and the distribution of incoming material. The building is expected to be ready for occupancy by the middle of October of this year. Olsen and Urbain, architects, were the designers.

Dr. J. E. Shepherd, Engineering Director for Electron Tubes at Sperry Gyroscope Co., and a Director of the Institute of Radio Engineers, was recently elected President of the Technical Societies Council of New York, Inc. Dr. Shepherd was named at the third annual meeting of the Council on Thursday night May 19 at the Engineering Societies Building, New York, N. Y.

To celebrate the beginning of its fiftieth anniversary, Leeds & Northrup Co. played host to 3500 employees and their guests at a dinner, entertainment, and dance in Convention Hall, Philadelphia, on the night of June 4. The company is an internationally known manufacturer of electrical measuring instruments, automatic controls, and heat-treating furnaces. A gold 50-year service plaque was presented to Morris Leeds, founder of the company, and now chairman of the board.

John K. Hodnette, Vice-President and General Manager of Industrial Products, Westinghouse Electric Corp., Pittsburgh, Pa., has announced the appointment of three executives who will hold key responsibilities in the sale and engineering of such products. The appointees and their new positions are: Tomlinson Fort, Manager, Apparatus Sales Department; William W. Sproul, Sales Manager, Industrial Products; Royal C. Bergvall, Engineering Manager, Industrial Products.

The Dearborn Chemical Co., Chicago, manufacturer of water-treatment chemicals, has appointed W. R. Wieschendorff as district manager of its Western office with headquarters in Los Angeles. He will also supervise the San Francisco and Seattle branches.

Precision Scientific Co. of Chicago, Ill., makers of scientific research and product control apparatus, has opened a branch office in San Francisco. Walter A. Blair has been placed in charge and will be located at 302 Hobart Building, 582 Market St., San Francisco 4, Calif. Before coming to Precision Scientific Co., Mr. Blair was a Product Design Engineer with the Fansteel Metallurgical Corp. of North Chicago.

Ivan L. Nixon, Vice-President in Charge of Bausch & Lomb Optical Company's Scientific Instrument Division, and one of the optical industry's most widely known figures, died Saturday, June 25, 1949. Associated with Bausch & Lomb for more than 40 years, his contributions to the scientific instrument field were many and varied.

The Progress of A.S.T.M.

Annual Address by the President, R. L. Templin,[1] June 28, 1949

I AM sure that members of the American Society for Testing Materials are interested in the progress of the Society. Those interested in the historical progress of the organization will find it has been ably presented on a number of occasions by former presidents. A particularly noteworthy review covering the first half-century of the organization was given by President A. W. Carpenter in 1947.

A complete and factual review of the progress made recently can be obtained from a perusal of the Annual Report of the Board of Directors and, in fairness to those you have selected to administer the affairs of the Society and as evidence of your interest as members, it merits your serious consideration.

The satisfactory future progress of our Society, in accordance with its basic purposes, requires that the activities of the Society be kept closely attuned to the needs of those whom it serves. These include industry, other technical societies, the U. S. Government, technologists, and many others. With the primary objectives of promoting the knowledge of and the standardizing of materials and test methods, many opportunities are presented for expanding the scope of the activities of the Society. The need for more standards and test methods suitable for the development and application of new materials is very much in evidence. While this has been recognized by others, the fact still deserves emphasis by repetition.

For satisfactory progress it is necessary frequently to review specifications and test methods which were suitable for the purposes of yesterday but which may be inadequate for those of today and tomorrow. In past years, for example, emphasis has been placed upon test methods which were intended to be a part of material or product specifications. In many instances the methods have been defined only in sufficient detail suitable for routine inspection tests. When these tests are used for more precise investigation of the materials the deficiencies in the test method details often become manifest. Specifically, the standard round, ½-in. diameter, tension test specimen for metals as specified by A.S.T.M. has proved to be quite satisfactory for routine inspection in so far as tensile strength, yield point or yield strength, elongation and reduction in area are concerned, but it is not suitable for precise determination of the tensile modulus of elasticity.

The use of dissimilar rectangular cross-section tension specimens for certain metal products makes comparisons of elongation values difficult or erroneous when different permissible sizes of specimens are involved.

The cold bend test is called for in a number of our metal product specifications, yet we do not have a standard detailed method for making this test. Under such conditions the bend requirements lose much of their significance.

The shearing properties of materials are often of interest to designers of engineering structures, but A.S.T.M. has no standard methods for making shearing tests of metals. Again, the fatigue properties of metals are very important to designers of machines and structures subjected to repeated loads, but so far no standard fatigue testing procedures for metals have been adopted by our Society.

Although we have standards for verification of testing machines and load measuring devices for checking testing machines, yet currently we have no standards for strain or deformation measuring apparatus.

These examples are some with which I am familiar but there are undoubtedly numerous others in the same category in the many fields of interest to our Society.

Many tests not directly a part of product specifications are often used for the improvement of commercial products and the development of new products. Currently too few of the users of these tests appreciate the merits of suitably standardized test methods for the purposes just indicated. In most tests, factors exist which, if not properly controlled, will cause substantial variations in test data. These differences in results may be erroneously attributed to the variables being studied, whereas in reality they are caused by uncontrolled variations in testing procedure. Departures from the standard sizes and geometry of tension test specimens in investigational studies of metals are often in evidence. Much attention, therefore, must be given to all the details involved when carrying out investigational testing, in order to attain precision.

Presumably many of the new products now being developed will require standards and undoubtedly some of these materials will require new tests. Certainly new uses of both old and new products often indicate the need for new tests. The technical symposia sponsored by A.S.T.M. have proved to be an effective means for developing these needs.

To deal adequately with the problems that have been only briefly indicated, much additional experimental or research work will be required. A considerable amount of such work is currently in progress as shown by the papers presented at this Annual Meeting, but more work will be necessary before suitable standards can be adopted. Effort of this character serves to emphasize the interest of our Society in research.

The increasing number and variety of new materials and their practical applications have increased the opportunities of A.S.T.M. and broadened the horizons of its interests. If we take proper advantage of the possibilities thus afforded, there need be no concern about the future progress of our Society.

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[1] Assistant Director of Research and Chief Engineer of Tests, Aluminum Company of America, New Kensington, Pa.

Aluminum Condenser and Heat Exchanger Tubes

By J. S. Hamilton[1] and J. J. Bowman[2]

THE Society's Committee B-7 on Light Metals recently prepared a specification (B 234–48 T) covering two types of aluminum-alloy drawn tubes for use in condensers and heat exchangers.[3] It is the purpose of this short note to provide information about these materials which may help to evaluate their usefulness.

The two alloys covered by the specification are designated M1 and M1 Clad, and they differ principally in that M1 Clad tubes are more resistant to perforation under certain corrosion conditions. For most applications, M1 tubes are adequately resistant to corrosion, but when salts of heavy metals such as copper, tin, nickel, or lead are present, even in comparatively small amounts, the contaminated water may induce severe pitting or perforation of the tubes. Under such conditions, the use of M1 Clad tubes is recommended.

The superior resistance of M1 Clad tubes is the result of an alclad coating on the inside surface of the tube. The coating comprises about 10 per cent of the wall thickness and is of an alloy containing about 1 per cent zinc, which is anodic to the M1 alloy (1.3 per cent manganese, balance aluminum) in most waters. The coating alloy is applied during the initial stages of manufacture and, in the finished tube, is integrally bonded to the M1 "core."

The fundamental manner in which an alclad coating protects an aluminum alloy from attack in severely corrosive exposures is so well known that little need be said about it here. The coating alloy, of course, is not completely immune to attack and will, in time, develop pits which penetrate to the bond between the "core" and coating. Electrolytic action then prevents corrosion of the "core" and perforation of the tube, at least until the area of the pit has increased so greatly as to reduce the electrolytic action because of the increased resistance in the electrolyte.

The specification covers tubes in a temper which combines good strength with a generally satisfactory level of workability. With few exceptions, the committee was informed, tubes in this temper can be expanded into tube sheets using the same practices and tools that are used for other materials. If preliminary tests indicate that the workability is inadequate, the tubes can be end-annealed and can then be expected to expand as much as 30 per cent using the 60-deg. expansion tool described in A.S.T.M. Specification B 153.[4]

When the operating temperature range is not too great, the aluminum-alloy tubes can be used in conjunction with steel tube sheets without danger of working loose. Corrosion of the ends of the tubes, because of contact with the steel, is generally negligible unless the chloride content of the cooling water exceeds about 50 ppm. If brackish or sea water is used, tube sheets of a suitable aluminum alloy should be used. Tube sheets of copper-base alloys must always be avoided.

Allowable working pressures for the tubes covered by specification B 234 are given in Table I. This table was prepared by the Aluminum Research Laboratories and the values are based on the criteria noted below the table.

Aluminum-alloy condenser and heat exchanger tubes have been used successfully in the production of acetic and other aliphatic acids, acetaldehyde, naval stores, vegetable oils, formaldehyde, hydrocyanic acid, in the ammonia recovery steps of the soda ash process, in condensing sweet and sour hydrocarbon gases and liquids, in furfural and other types of lubricating oil-solvent extractions processes, and in condensing steam. They have been used in air- and water-cooled atmospheric heat exchangers, air and natural gas compressor intercoolers and after coolers, lubricating oil and jacket water coolers, and numerous other types of heat exchangers.

TABLE I.—ALLOWABLE INTERNAL AND EXTERNAL WORKING PRESSURES FOR M1 AND M1 CLAD TUBES.[a]

Nominal Inside Diameter, in.	Nominal Wall Thickness		Allowable Internal Working Pressure, psi.[b] For Metal Temperatures Not Over					Allowable External Working Pressure, psi.[c] For Metal Temperatures Not Over				
	in.	Stubs Gage	100 F.	200 F.	300 F.	400 F.	500 F.	100 F.	200 F.	300 F.	400 F.	500 F.
¾	0.049	18	645	590	515	410	290	530	460	360	225	120
	0.065	16	870	800	695	555	390	765	655	515	335	175
⅞	0.049	18	550	505	440	350	245	425	375	295	175	90
	0.065	16	740	680	590	475	335	630	540	425	270	150
	0.083	14	960	885	770	615	430	850	730	575	380	190
1	0.065	16	640	590	515	410	290	525	460	360	220	120
	0.083	14	830	765	665	530	375	725	620	490	315	165
	0.109	12	1115	1030	895	715	505	1000	850	576	435	220
1¼	0.065	16	505	465	405	325	230	385	335	265	160	79
	0.083	14	655	605	525	420	295	545	470	370	230	125
	0.109	12	875	805	700	560	395	770	660	520	340	175
	0.120	11	975	895	780	625	440	865	735	580	385	190

[a] No allowance has been made for any reduced efficiency which may be encountered at joints.

[b] The allowable internal working pressure, including a factor of safety of 4, is based on the following formula:

$$P = \frac{0.95S}{4} \times \frac{D^2 - d^2}{D^2d^2}$$

where:

S = the minimum tensile strength in pounds per square inch,
D = the nominal outside diameter in inches, and
d = the nominal inside diameter in inches.

The factor 0.95 is used to take care of factors such as the difference between the longitudinal and circumferential tensile strength.

[c] The allowable external working pressure, including a factor of safety of 4, is based on the theory developed in "A Study of the Collapsing Pressure of Thin-Walled Cylinders," by R. G. Sturm, *Bulletin*, University of Illinois Engineering Station, Series No. 329.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Development Engineer, Aluminum Company of America, New Kensington, Pa.

[2] Metallurgical Division, Aluminum Company of America, Pittsburgh, Pa.

[3] Tentative Specifications for Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers (B 234–48 T), issued as separate reprint.

[4] Standard Method of Test for Expansion (Pin Test) of Copper and Copper Alloy Tubing (B 153–47), 1947 Supplement to Book of A.S.T.M. Standards, Part I-B, p. 96.

A New Durability Test for Marble

By D. W. Kessler[1]

SYNOPSIS

Research leading to the development of a new durability test is described. Six samples of weathered marble from known quarries or sources were collected for determining how well the laboratory test values correlated with actual weathering. For comparing results the following changes in properties were studied: increase in volume, decrease in compressive strength, and increase in absorption. It was found the increases in volume of the specimens during the laboratory test correlated well with the increases in volume during actual weathering. The test conditions produced changes in other properties similar to those that occurred during weathering, but the correlations for these were less satisfactory than for volume changes.

Marble can truly be termed "the aristocrat of building materials." Because of the great diversity of available colors and its unequaled workability, marble will probably always be a favorite of the architect and artist. The field of usage is unrivaled. For urns, it is known to have been used nearly 5000 years before the Christian era. The Romans carved bulletins on slabs of marble long before newspapers were thought of. There is a marble dam in Greece and a marble bridge in Vermont. Its beauty has inspired many novel uses such as radiator enclosures, lamp shades, one-piece bath tubs and even a marble boat. In the ceiling of the Lincoln Memorial in Washington, D. C., marble is employed to diffuse the light.

When a monumental structure is proposed, marble usually comes under consideration. If some member of the planning committee happens to recall an instance where this product did not give very satisfactory performance it may be ruled out without further consideration. A layman is apt to believe that marbles, like minerals, do not vary in properties from one deposit to another. Minerals of the same species do not vary appreciably, but aggregations of the minerals calcite and dolomite, forming marble, may differ greatly in different deposits or even from one part to another of the same deposit. Recognizable varieties of marble from one region as well as marbles from different regions are commonly referred to as different marbles. Using the term in this sense, it is well known that some marbles are not as durable when exposed to the weather as others.

About 1856, when our national capitol was being enlarged, a noted scientist[2] was called upon to test the marble proposed for use. He made a freezing test and decided that the marble would last for at least 10,000 years. Fortunately the selection was satisfactory, but the same test applied to practically any marble would have led to the same conclusion because this material is not appreciably affected by that kind of weathering.

Although something can be learned about the durability of marbles from different sources by visual observation of the materials while in place in old structures, information so obtained may be misleading, and frequently the observations do not give the specific information desired because the materials being studied may not correspond to the products now available. All marbles become rough on the surface after long exposure because of their low resistance to the acids in rain water. The extent of this action varies greatly in different locations, being most severe in cities where the combustion products of fuels are a source of sulfur gases. The roughening of the surface is not serious except for the undesirable appearance. Some marbles become rough at the surface but remain sound within while others become friable throughout and finally crumble down to a calcareous sand. This process is commonly called "sugaring" because the disintegrated material resembles sugar. Except in advanced stages of sugaring it is difficult to determine by visual observation whether the marble is sound or friable.

A means that has been used for judging the durability of stone is to examine the outcrops of ledges for weathering effects. This means has not proved of value because stone above ground, especially in masonry, is exposed to more severe conditions than it is in contact with the earth.

Experiments at the National Bureau of Standards with weak acids and acid-forming gases have shown that calcite marbles are attacked mainly on the surface. This is probably because the acids are quickly neutralized at the surface and do not penetrate sufficiently to enlarge the pores by solution between crystals. It was found possible to cause deterioration on dolomitic marbles by impregnating dry specimens with sulfur dioxide, then soaking them in water. About 30 cycles of this process produced sugaring. Since the results of such tests showed no satisfactory correlation with actual weathering they were not considered to be indicative of durability.

Appraisal of Durability Test Methods

So far as the author knows there has been no systematic study of the means commonly used in the laboratory for selecting marble with respect to durability. It is evident that too much reliance has been placed in test results determined on fresh samples for absorption, porosity, compressive strength, and resistance to acids and frost. A cursory study of the relation of the results of such tests to the actual weather resistance of a few varieties of marble will prove that such tests are of practically no value. A convincing instance of this

TABLE I.—DESCRIPTION OF WEATHERED SAMPLES.[a]

Marble Designation	Type	Color	Exposure Period and Location	Condition
M_1......	Coarse-grained dolomite	White	75 yr. in New York City	Surface rough, interior sound
M_2......	Medium-grained calcite	White	10 yr. in Washington, D. C.	Fairly sound
M_3......	Fine-grained calcite	White	83 yr. in Washington, D. C.	Unsound, parts crumbling
M_4......	Fine-grained calcite	White[b]	17 yr. in France	Some parts unsound
M_5......	Medium-grained calcite	White[b]	40 yr. in New York City	Surface rough, some unsoundness
M_6......	Medium-grained calcite	White[b]	16 yr. in Washington, D. C.	Surface rough, interior fairly sound

[a] The locations of the deposits from which the marbles originally came are as follows: 1 in New York, 1 in Colorado, 2 in Italy, and 2 in Vermont.
[b] Occasional dark veins.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Chief of Building Stone Section, National Bureau of Standards, Washington, D. C.

[2] Joseph Henry, "On the Mode of Testing Building Materials and an Account of the Marble Used in the Extension of the U. S. Capitol," *American Journal of Science*, Vol. 72, p. 30. (1856).

fact is found in the record of marble crosses erected in France to American soldiers about 1930. According to any of the above-mentioned tests the marble used in these markers would have been judged as satisfactory, but after 17 yr. of exposure most of them are in an advanced stage of deterioration.

Extensive tests have indicated that frost action is not an important agent of deterioration in marble. Observations on buildings and monuments in different climates substantiate this conclusion because marble appears to weather more rapidly in southern regions, where freezing seldom occurs, than in the north, if humidity conditions are comparable.

Labaratory Tests on Weathered Marble[3]

Because of the need for a laboratory means of determining the weather resistance of any particular marble, an investigation was undertaken at the National Bureau of Standards to determine what weathering agencies are most important and to simulate the weathering process in a test procedure. The first step was to collect samples of weathered marble for the purpose of studying the changes that had occurred. It is a difficult matter to secure old weathered marble which can be definitely identified as to source and grade, and only six samples have been obtained. From studies on these something has been learned about the weathering process and the rates of deterioration for products from different sources. Table I gives general information on the weathered marbles and Tables II, III, and IV give test results on the weathered samples in comparison with results on fresh samples of the same varieties. More complete information on the fresh samples used in the comparisons is given in footnote [b] of Table II. The data in the last column of Table II were obtained by dividing the total increase in expansion by the number of decades the marbles were exposed to the weather.[4]

From the original and final bulk density values, the increases in bulk due to weathering have been computed. Increases in absorption for some marbles were pronounced and show some degree of correlation with the swelling or "bulking" effect. It is evident that when a marble has reached the sugaring stage there is very little strength left. It might be assumed, therefore, that a determination of the compressive strength made on any sample of weathered material would give an indication of the amount of weathering that had occurred. On account of the variability in strength determinations and the fact that the original strength of the block under study can only be approximated, strength determinations are not apt to be conslusive except for advanced stages of weathering.

During the 83 years marble M_3 was exposed to the weather it increased in volume 4.2 per cent and became so unsound that the structure was dismantled and rebuilt. The final expansion value of this sample may prove to be of considerable value in further studies of durability since it probably represents the maximum this particular material can expand before becoming completely unsound. It will also be of interest to compare this expansion value with that of other marbles when they reach the sugaring stage.

Studies of Temperature Effects on Marble

Having found certain measurable changes that occur in marble during weathering and the rates of deterioration for some well-known products, the next step was to seek a laboratory process that would produce comparable changes in similar marbles.

[3] In tests for bulk density, absorption, and compressive strength, A.S.T.M. Standard Method of Test for Absorption and Bulk Specific Gravity of Natural Building Stone (C 97–47), 1947 Supplement to Book of A.S.T.M. Standards, Part II, p. 65, and Method of Test for Compressive Strength of Natural Building Stone (C 170–46), 1946 Book of A.S.T.M. Standards, Part II, p. 218, were followed except that in some of the tests on weathered marble it was necessary to use smaller specimens.

[4] Many believe that marble and other types of stone develop a protective film on the surface which serves as a protection and hence decreases the rate of weathering. There is no tangible proof of this theory; on the contrary, tests on marble M_2 at the end of five and ten years indicate that there is no decrease in the rate of weathering.

TABLE II.—PERMANENT EXPANSION OF MARBLE ON WEATHERING.[a]

Marble Designation	Bulk Density Tests						Total Volume Increase, per cent[c]	Estimated Volume Increase for 10 yr., per cent
	Fresh Marbles[b]			Weathered Marbles				
	Number of Specimens	Average, g. per cu. cm.	Standard Deviation, g. per cu. cm.	Number of Specimens	Average, g. per cu. cm.	Standard Deviation, g. per cu. cm.		
M_1	3	2.869	0.0017	12	2.854	0.0065	0.52	0.07
M_2	22	2.7043	0.0008	15	2.6983	0.0019	0.22	0.22
M_3	5	2.7101	0.0014	14	2.6009	0.0416	4.20	0.51
M_4	9[d]	2.7077	0.0007	2	2.6916	0.0007	0.60	0.35
M_5	4[e]	2.7060	0.0032	18	2.6572	0.0249	1.83	0.46
M_6	2	2.7045	0.0005	2	2.6805	0.0005	0.90	0.56

[a] Test results were obtained on one sample of each marble except as noted otherwise.
[b] The fresh samples of M_1, M_2, M_4, and M_6 were taken from the same quarries as those tested for weathering effects. In the cases of M_3 and M_5 it was impossible to secure fresh samples from the same quarries as those supplying material for the structures that were tested for weathering effects. In these cases the best that could be done was to use similar marbles from the same regions for determining the test values on fresh marble.
[c] The percentage volume increases may be computed by the formula:

$$V_i = \frac{(G_f - G_w)100}{G_w}$$

where G_f is the bulk density of the fresh marble and G_w that of the weathered.
[d] Three tests on each of three samples.
[e] One test on each of four samples.

TABLE III.—ABSORPTION INCREASE OF MARBLE ON WEATHERING.[a]

Marble Designation	Absorption						Absorption Increase, per cent	
	Fresh Marble[b]			Weathered Marble				
	Number of Specimens	Averages, per cent	Standard Deviation, per cent	Number of Specimens	Average, per cent	Standard Deviation, per cent	Total for Period Shown in Table I	Estimated Increase for 10 Yr.
M_1	4	0.0865	0.0051	12	0.1133	0.019	31.0	4.1
M_2	22	0.1054	0.0123	20	0.1607	0.022	52.4	52.4
M_3	5	0.0690	0.0151	14	1.2747	0.415	1745.	210.
M_4	9[c]	0.1026	0.0081	6	1.401	0.070	291.	171.
M_5	4[d]	0.0770	0.0050	18	1.6172	0.239	700.	175.
M_6	2	0.1450	0.015	2	1.435	0.017	200.	125.

[a] Test results were obtained on one sample of each marble except as noted otherwise.
[b] See note [b], Table II.
[c] Three tests on each of three samples.
[d] One test on each of four samples.

TABLE IV.—DECREASE OF COMPRESSIVE STRENGTH OF MARBLE ON WEATHERING.[a]

Marble Designation	Tests on Fresh Marble			Tests on Weathered Marble[b]			Decrease in Strength, per cent	
	Number of Specimens	Average, psi.	Standard Deviation, psi.	Number of Specimens	Average, psi.	Standard Deviation, psi.	Total for Period Shown in Table I	Estimated Loss for 10 Yr.
M_1	4	17 595	1262	12	16 117	2137	8.4	1.1
M_2	18	9 931	1970	28	8 775	1538	10.6	10.6
M_3	4	15 544	2256	14	5 185	1416	67.0	8.1
M_4	3	16 463	549	6	8 973	3602	45.4	26.7
M_5	4	12 225	248	18	7 368	2083	40.0	10.0
M_6	6	10 105	828	2	5 910	1900	41.5	26.0

[a] Test results on one sample in each case.
[b] Since it was impossible to prepare specimens from the most friable parts of some samples, the average values obtained for M_3 and M_5 (weathered) are evidently too high.

Several years ago some work on thermal expansion[5] showed that when marble is heated and then cooled it does not return to the original dimensions. Each heating cycle produced an increment of "growth" which was assumed to be due to the peculiar thermal expansion of calcite crystals. The thermal coefficient along the principal axis of a calcite crystal has been determined as 0.0000225 per degree centigrade and at right angles to that direction −0.000005. This means that as the temperature increases there is an elongation of the crystal in one direction accompanied by a shrinkage in another direction. It may be assumed that each temperature change will produce stresses in a closely packed mass of calcite crystals as in marble. Movements between adjoining surfaces of crystals are inevitable and the increments of growth are probably the result of crystals being moved out of their original positions with reference to each other.

It was decided to study the effect of numerous heating and cooling cycles on various marbles in order to determine whether or not the rates of permanent expansion were indicative of durability. For convenience in preparation and testing, simple specimens $2\frac{1}{8}$ in. in diameter and $2\frac{1}{2}$ in. long, were used. Volumes were first measured in a mercury volumenometer giving dependable values to about one part in 40,000 on smooth-surface specimens. After determining the original volumes of several specimens they were then put through numerous cycles of heating to 105 C. and cooling to 25 C. with volume determinations after each 10 or 20 cycles. Since the specimens were placed in an oven which was already heated to 105 C. it is likely that they became heated through to 105 C. within an hour or less but they were left in the oven for four hours or more. When the specimens were removed for cooling, they were set on a thick soapstone slab in the laboratory and cooling to room temperature required somewhat more than an hour. The magnitude of the volume changes for 10 cycles indicated that a less accurate and more convenient method of measurement would be satisfactory. The volumes were then determined by weighing the specimens in water. By careful manipulation an accuracy of about one part in 8000 could be obtained, which is sufficiently exact. By weighing the specimens in air, after soaking in water for about 24 hr., then weighing them in water, errors due to absorption were eliminated.[3] This method had the advantage of more speed and the absorption values could be determined at the same time. Numerous specimens were tested for 70 cycles or more with volume measurements at convenient intervals. A few typical curves are shown in Fig. 1 for this series of tests in which the specimens were dry except for the times of volume measurements when they were soaked in tap water for 24 hr. In cases where volume increases by both methods were determined on specimens of the same marble for heating and cooling, it was found that considerably greater increases occurred for those measured in mercury. This was attributed to the fact that the specimens were continually dry throughout the procedure when the mercury method was used. Possibly soaking in water enables some degree of readjustment to be made among the crystals of marble when under stress.

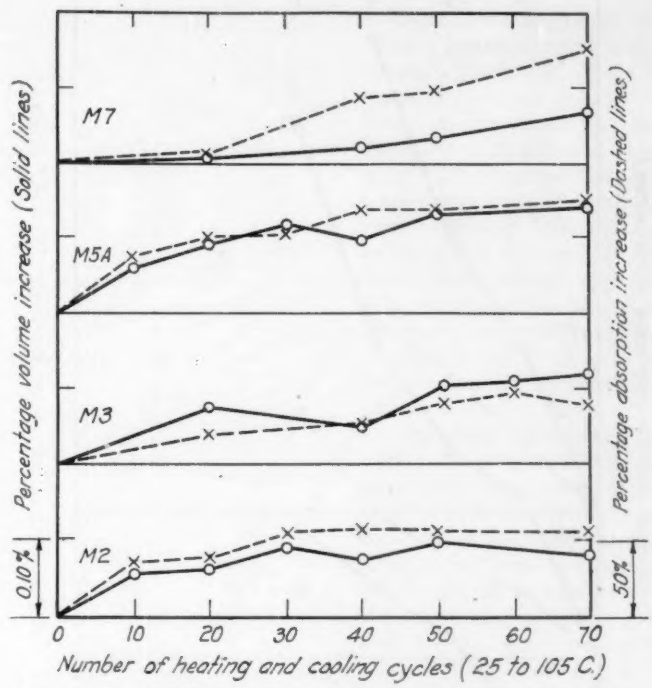

Fig. 1.—Permanent Increase in Volume and Absorption of Marble with Number of Heating and Cooling Cycles.

The curves in Fig. 1 show unexpected irregularities in rates of volume increase. The recurrence of inflections leads to the belief that these are not due to errors of measurement. In a large number of the tests there was a rather rapid increase in volume for the first 30 or 40 cycles followed by decreases for several cycles. This may be caused by a stressed condition developing within the marble due to crystals being forced out of position and the resisting forces occasionally becoming sufficient to cause partial readjustment. The curve designated M_{5A} was obtained by averaging the results for four similar samples from the region.[6] The curve for M_7 was added to Fig. 1 because it shows the performance of a marble which is believed to be relatively free of sugaring tendencies.

Although there appeared to be some degree of correlation between the volume increase and the durability, the differences in volume increase for various marbles were rather small. Furthermore, the volume increased very little after 100 cycles, while the actual weathering of marble appears to progress uniformly.[4] It was assumed that some other factor was playing a part in the process.

The Gypsum Test and Correlations with Weathering

Since there are water-soluble salts in masonry, it was considered possible that the deposition of salt crystals between calcite crystals while in a stressed condition might prevent them from slipping back after being moved out of position by a temperature change. In order to test this hypothesis a procedure was devised which involved setting specimens in Petri dishes with 2 g. of gypsum and 25 ml. of water, then heating them for 4 hr. or more to 105 C.[7] Gypsum is soluble to the extent of about 1 part in 400 parts of water. During heating, the water evaporated and a small amount of gypsum was carried into the pores of the marble while hot. The cycle was re-

[5] W. H. Souder and Peter Hidnert, *Scientific Paper No. 352*, Nat. Bureau Standards, Vol. 15 (1919).

[6] See note *b* following Table II.

[7] This test has been adopted as A.S.T.M. Tentative Method of Test for Combined Effect of Temperature Cycles and Weak Salt Solutions on Natural Building Stones (C 218–48 T), 1948 Supplement to Book of A.S.T.M. Standards, Part II, p. 140.

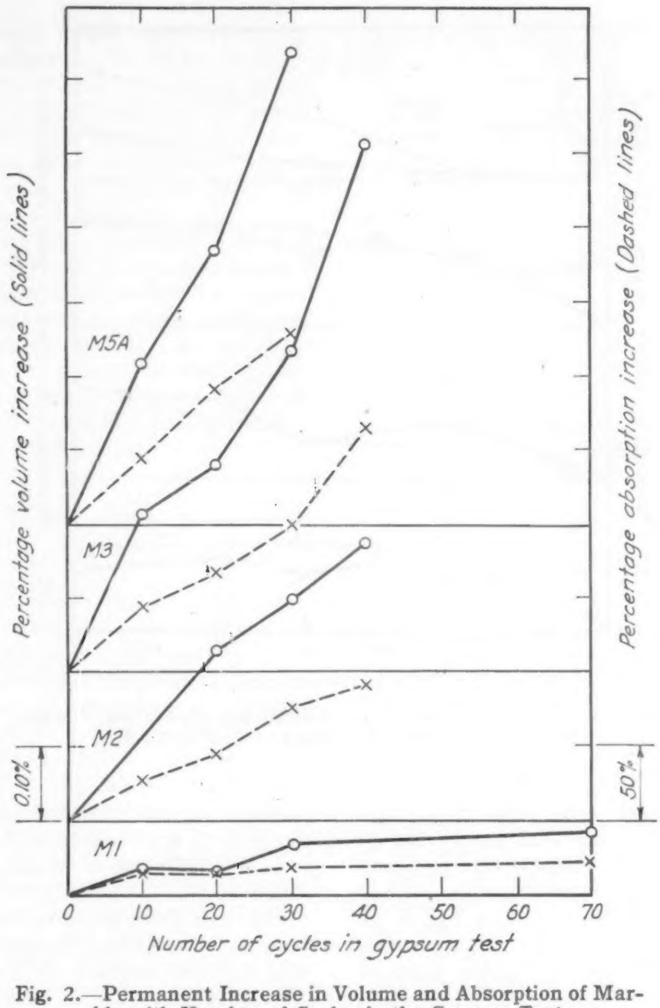

Fig. 2.—Permanent Increase in Volume and Absorption of Marble with Number of Cycles in the Gypsum Test.

peated by adding more water after cooling the specimen. Volumes and absorptions were determined after each 10 or 20 cycles. This treatment caused comparatively large increases in volume and absorption, and the changes occurred at a fairly constant rate. Furthermore, the magnitude of these increases differed for different marbles much more than in the case of temperature cycles without the gypsum.

Figure 2 includes the curves for volume and absorption increases in the gypsum test on two fresh marbles taken from the same quarries as the weathered materials M_1 and M_2. It was impossible to get fresh samples of M_3 and M_5 from the same quarries, hence similar samples from the same regions were used in the laboratory test. The curve marked M_{5A} was obtained by averaging the results of four fresh samples taken from the same vicinity as M_5. In order to compare equal weathering periods, the total expansions for the different samples in Table II were divided by the number of decades they were exposed. The expansion of each marble during the ten-year weathering period was plotted against the expansion for 30 cycles in the gypsum test in Fig. 3, which shows that for four of the samples the correlation between the test values and the expansion rates for actual weathering was good. The correlation coefficient computed for the six marbles was $r = 0.891$. Apparently the deterioration of sample M_3 (as measured by expansion) proceeded more rapidly during actual weathering than the test value would indicate while the converse is true for sample M_6. In general, the results in Tables II to VII indicate that the test produces changes of the same kind as actual weathering. The degree of correlation between volume increases of the six marbles during actual weathering and in the laboratory test indicates that the test will be of value in selecting marbles for use on the exterior of structures.

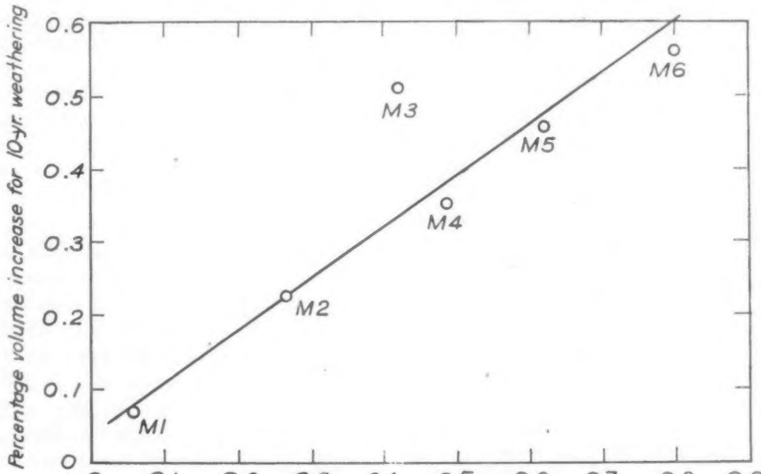

Fig. 3.—Correlation of Permanent Expansion Caused by Weathering and by the Gypsum Test for Six Marbles.

Gypsum was used for the salt in the test procedure in order to assure a control on the strength of solution. Although the solubility varies somewhat with the temperature, being greater for lower temperatures, the range is not great.

In order to find how a compound of lower solubility would perform in a test of this kind, several marbles were tested by replacing the gypsum with hydrated lime. The solubility of this hydrate is about one part in 600 parts of water. The effect on most marbles was similar to that of the gypsum test but the rate of deterioration as indicated by absorption and volume increases was somewhat slower. On some of the denser marbles the rates were about the same as for the gypsum test.

Discussion of Results

Marble in masonry structures is probably always exposed to sodium and potassium salts as well as to gypsum and other lime compounds. It might be expected that this would produce a more

TABLE V.—PERMANENT EXPANSION OF MARBLES IN DURABILITY TEST.[a]

Marble Designation	Bulk Density Tests: On Fresh Marble, Number of Specimens	Average, g. per cu. cm.	Standard Deviation, g. per cu. cm.	After 30 Cycles, Number of Specimens	Average, g. per cu. cm.	Standard Deviation, g. per cu. cm.	Permanent Volume Increase, per cent
M_1.......	3	2.8458	0.0009	3	2.8441	0.0008	0.06
M_2.......	1	2.6995	...	1	2.6922	...	0.27
M_3.......	1	2.7046	...	1	2.6932	...	0.42
M_4.......	9[b]	2.7077	0.0007	9[b]	2.6945	0.0037	0.49
M_5.......	4[c]	2.7026	0.0019	4[c]	2.6862	0.0061	0.61
M_6.......	1	2.7012	...	1	2.6799	...	0.80

[a] A.S.T.M. Method C 218–48 T. Test results on one sample except as noted otherwise.
[b] Three tests on each of three samples.
[c] One test on each of four samples.

TABLE VI.—INCREASE IN ABSORPTION IN DURABILITY TEST.[a]

Marble Designation	Tests on Fresh Marbles: Number of Specimens	Average, per cent	Standard Deviation, per cent	Tests on Marbles After 30 Cycles: Number of Specimens	Average, per cent	Standard Deviation, per cent	Absorption Increase, per cent
M_1........	3	0.102	0.0074	3	0.119	0.0087	16.7
M_2........	1	0.121	...	1	0.212	...	75.2
M_3........	1	0.128	...	1	0.256	...	100.
M_4........	9[b]	0.102	0.0081	3	0.237	0.0508	132.
M_5........	4[c]	0.120	0.0100	4[c]	0.331	0.0614	176.
M_6........	1	0.148	...	1	0.404	...	173.

[a] A.S.T.M. Method C 218. Test results on one sample except as noted otherwise.
[b] Three tests on each of three samples.
[c] One test on each of four samples.

TABLE VII.—COMPRESSIVE STRENGTH LOSS IN DURABILITY TEST.[a]

Marble Designation	Tests on Fresh Marble: Number of Specimens	Average, psi.	Standard Deviation, psi.	Tests After 30 Cycles: Number of Specimens	Average, psi.	Standard Deviation, psi.	Strength Loss, per cent
M_1........	3	11 680	645	3	10 467	561	10.5
M_2........	18	9 930	1970	1	7 150	...	28.0
M_3........	4	15 544	2596	1	12 830	...	17.5
M_4........	3	16 463	549	6	14 147	349	14.0
M_5........	4	12 225	247	3[b]	8 420	889	31.0
M_6........	6	10 105	828	1	7 558	...	25.2

[a] Test results obtained on one sample in each case except as noted otherwise.
[b] One test on each of three samples.

severe condition and cause marble in masonry to weather faster than in monuments where little mortar is present. The available data do not, however, support such expectation. Of the six weathered samples studied, M_1, M_3, and M_5 were in masonry structures and the others were in monuments or similar exposures. In a location where sulfur gases are not present in the air one might expect a slower rate of weathering in monuments.

It may be argued that volume increase during weathering cannot be accurately determined by measuring changes in bulk density. If appreciable enlargement of the pores between crystals occurs, as a result of acid action, this would cause a decrease in bulk density and vitiate the results of calculations. If such effects of acids actually occur, it would evidently cause rounding of crystals by acting more rapidly on sharp edges. Examination of sugared marble under magnification does not show any signs of rounding, and the crystals appear to be as sharp as in unweathered marble. Furthermore, the bulking effect has been checked by length measurements on marble slabs exposed to the weather for a period of a few months and found to be appreciable.

Correlations between changes in absorption or strength during actual weathering and in the durability tests were not very satisfactory. The determination of changes in any property involves a comparison of the final test values with those for fresh marble. It is impossible to know the exact initial values for the actual piece of marble tested for weather effects. These can only be approximated from tests on other samples of fresh marble from the same source. Since the strength and absorption are quite variable properties, the values obtained from tests on another block may be considerably different from the original values of the block under consideration. Bulk density is a much less variable property of marble, which fact may be readily inferred from the standard deviations in Table II. Many tests were made on marble M_2, hence it affords a good example of the variation in properties. Expressing the standard deviations for fresh marble as a percentage of the mean, one obtains 0.03 per cent for bulk density, 11 per cent for absorption, and 20 per cent for compressive strength. These values indicate that one is not apt to make a large error in the assumption of the original value of bulk density, but for the other two properties a large error may be introduced. This probably accounts in part for the fact that much better correlations were obtained for increases in volume during weathering and in the test for durability than was found for changes in other properties.

Conclusions

1. Marbles from different sources may differ greatly in durability.
2. The commonly used laboratory tests on fresh marble for absorption, strength, frost, and acid resistance do not satisfactorily distinguish between marbles of poor and good durability.
3. In all the weathered marbles studied, decreases in strength and increases in absorption and volume had occurred.
4. The gypsum test devised at the National Bureau of Standards for determining the durability of marble produces changes of the same kind that occur in such materials during weathering, such as increases in volume and absorption and decreases in strength.
5. The correlations between the increases in volume for six marbles during weathering and in the new durability test indicate that the test will be of value for selecting marbles for use on the exterior of structures.

Discussion on Paper Regarding the Sonic Determination of Modulus of Elasticity Using Round-Section Bars[1]

Mr. Alfred R. Decker.[2]—The simplicity, convenience, and accuracy of the sonic method has led to its widespread use.[3–10] It is important, therefore, to call attention to an error of considerable magnitude in the method for computing the modulus for bars of round cross-section given in the frequently listed paper by Powers.[1]

The sonic method depends on the relationship, for a given bar-shaped specimen, between natural frequency of vibration, density, dimensions, and modulus of elasticity. The last is computed from measured values of the preceding factors.

[1] T. C. Powers, "Measuring Young's Modulus of Elasticity by Means of Sonic Vibrations," *Proceedings*, Am. Soc. Testing Mats., Vol. 38, Part II, p. 460 (1938).

[2] Ceramic Division, Research Laboratories, Champion Spark Plug Co., 8525 Butler Ave., Detroit 11, Mich.

A frequently-quoted basic equation is Mason's[11] (shown here for gravitational units):

$$E = \frac{4\pi^2 l^4 f^2 D}{g m^4 k^2} \quad \ldots\ldots\ldots\ldots (1)$$

where:

- E = modulus of elasticity in pounds per square inch,
- l = length of bar in inches,
- f = natural frequency of vibration in cycles per second,
- D = apparent density of bar in pounds per cubic inch,
- g = acceleration due to gravity, 386 in. per second per second,
- m = factor depending on ratio of depth (thickness or diameter) to length (for very long, thin bars m = 4.73), and
- k = radius of gyration of cross-section. For rectangular section of thickness, t, $k^2 = t^2/12$; for round-section of diameter, d, $k^2 = d^2/16$.

Mason shows a curve giving the value of m for any given ratio of depth to length of the bar. This factor corrects for rotary inertia. An expression depending on Poisson's ratio, μ, is given for modifying the ratio, r, to correct also for lateral inertia ($r' = r(1 + \mu)^{1/2}$). Specific reference is made only to bars of rectangular cross-section.

For bars of round cross-section, Powers[1] adopts Mason's equation and reproduces his chart of values for m, but adds to the chart a statement that for round bars the indicated value of m is multiplied by the factor 1.07. Herein lies the error which gives rise to values for E 24 per cent too low since m occurs to the fourth power in the denominator.

This error was discovered experimentally when it was observed that tests of rectangular and round bars of the same material were not in agreement except when Mason's values for m were used in both cases. The correctness of this procedure has been confirmed on a theoretical basis by Mason.[12] In applying his equation to round bars the only changes are in the radius of gyration, k, and the substitution of diameter for thickness in determining the depth to length ratio.

Experimental results for vitrified ceramic specimens show good agreement between values for E determined from various shapes of bar. A maximum deviation from the average value for E of only 2 per cent was obtained from tests of specimens of one composition with the following different dimensions and shapes: $^1/_4$ in. thick by $4\frac{1}{2}$ in. long, $^1/_4$ in. thick by 6 in. long, $^1/_4$ in. round by $4^1/_4$ in. long, $^1/_4$ in. round by 5 in. long, and $^1/_4$ in. round by 10 in. long.

The depth to length ratio varies from 0.043 to 0.058. An extension of this comparison to bars of greater ratio would be interesting because of Pickett's[9] question as to the validity of Mason's fundamental differential equation.[13] With vitrified ceramic specimens of the size range given in the preceding paragraph, however, the practical upper limit for the ratio is 0.067 when the method depends on the tone emitted by the vibrating bar. The measurement of frequency becomes increasingly difficult as the ratio increases due to lowered volume and much more rapid attenuation of the tone.

Within this practical limit (ratio less than 0.067), values for E calculated after Mason[14] and after Pickett differ by less than 1 per cent, so it makes little difference which is followed. Indeed for round bars with ratios up to 0.200 Mason's and Pickett's results differ by less than 1 per cent; for similar rectangular bars Mason's values gradually become less, reaching 5.8 per cent below Pickett's.

[3] G. Grime, "Determination of Young's Modulus for Building Materials by a Vibration Method," *Philosophical Magazine*, Vol. 20, August, 1935, pp. 304–310; *Ceramic Abstracts*, Vol. 15, No. 5, p. 150 (1936).

[4] G. Grime and J. E. Eaton, "Determination of Young's Modulus by Flexural Vibration," *Philosphical Magazine*, Vol. 23, No. 152, pp. 96–98 (1937); *Ceramic Abstracts*, Vol. 16, No. 7, p. 223 (1937).

[5] Leonard Obert, "Sonic Method of Determining Modulus of Elasticity of Building Materials Under Pressure," *Proceedings*, Am. Soc. Testing Mats., Vol. 39, pp. 987–995 (1939).

[6] F. B. Hornibrook, Discussion on Application of Sonic Method to Freezing and Thawing Studies of Concrete, *Ibid.*, pp. 996–997.

[7] Allen King, "New Method of Measuring Young's Modulus," *Review of Scientific Instruments*, Vol. 11, No. 7, pp. 114–116 (1940).

[8] S. V. Forgue and G. A. Loomis, "Modulus of Elasticity of Dinnerware Bodies by a Sonic-Vibration Method," *Bulletin*, Am. Ceramic Soc., Vol. 20, No. 12, pp. 425–430 (1941).

[9] Gerald Pickett, "Equations for Computing Elastic Constants from Flexural and Torsional Resonant Frequencies of Vibration of Prisms and Cylinders," *Proceedings*, Am. Soc. Testing Mats., Vol. 45, pp. 846–865 (1945)

[10] Kenneth A. Baab and Hobart M. Kraner, "Sonic Method for Determining Young's Modulus of Elasticity," *Journal*, Am. Ceramic Soc., Vol. 31, No. 11, November, 1948, pp. 318–320.

[11] W. P. Mason, "Motion of Bar Vibrating in Flexure, Including Effects of Rotary and Lateral Inertia," *Journal*, Acoustical Soc. Am., Vol. 6, April, 1935, pp. 246–249.

[12] Personal communication dated October 28, 1948.

[13] Both obtain the same equation for E: the difference lies in the values assigned to m as the ratio of depth to length changes.

[14] The procedure used included the correction for both rotary and lateral inertia.

NOTE BY MR. T. C. POWERS (*author*).—Mr. Decker is quite correct: The note that appears in Fig. 1 of my paper should be deleted. On checking the old records, I find that the note, based on an erroneous definition of m, was added as an afterthought, just before sending the manuscript to the printer. The note was not adequately verified. Having worked almost entirely with rectangular specimens and having adopted the equations given by Pickett, we did not discover the error. Mr. Decker is to be thanked for calling attention to this error.

Performance Testing of Packages in Relation to Handling and Shipping

By Julian Harrison Toulouse[1]

EDITORIAL NOTE.—This paper is the text of a talk given by Mr. Toulouse at the Great Lakes Material Handling Conference held in Toledo, Ohio, on June 13, 1949. Mr. Toulouse, who is Chairman of Subcommittee IV on Performance Standards of A.S.T.M. Committee D-10 on Shipping Containers, discusses the performance testing of packages from the standpoint of Committee D-10's work. It was, therefore, felt that this paper would be of interest to ASTM BULLETIN readers.

WHILE much of material handling is concerned with bulk commodities such as ore, sand, cement, grain, coal, and the like and in the handling of unpackaged materials during production or manufacture, one of the large fields is that in the handling of packages, particularly in warehousing and shipping. Such packages may be of all types, including the familiar corrugated carton, the wood box, barrels, drums, wood crates, wirebound crates, bags, and the like. This paper discusses these from

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the standpoint of A.S.T.M. Committee D-10 on Shipping Containers, particularly in relation to the work of Subcommittee IV of that Committee. As chairman of this subcommittee I can speak from recent activities in meetings which have been held for the purpose of developing performance standards.

There are a number of published A.S.T.M. tests that apply to performance of packages. In most cases, these give specific equipment and instructions for conducting the tests. They have been very well establishd in past years, but the choosing of standard tests that might correlate with certain shipping hazards is a matter which has not received much attention until recently. It should readily be recognized that while one might employ tests of package strength and protective performance, it takes a good deal of experience and cooperative work to establish the levels on each of these tests that might be synonymous with various types of handling. Since this work is just under way at present, we cannot report that any standards have been adopted, but I wish to discuss the thinking that has been brought out in recent meetings that might eventually lead to the choice of standards.

Just as soon as we began to study these tests in relation to shipping performance, it was apparent that the size and weight of the package had a great deal to do with the application of the tests. For this reason we are now contemplating various weight classifications. Among them are such brackets as 0 to 50 lb. with a possible subbracket inside of this range of 0 to 20 lb. This might be considered the "one man throwing limit," in that packages of such weight might easily be tossed onto piles or in other ways handled with some degree of hazard due to their light weight. Above this we have tentatively considered the weight between 50 and 100 lb. as being a "one man dropping limit," in that these packages are somewhat heavy to be thrown but still could be carried and therefore dropped from considerable heights. Above this is another tentative bracket from 100 to 300 lb. which might be considered a "two man dropping limit;" such packages might not be dropped as far as those of lighter weight. Still further might be a bracket from 300 to 1000 lb. which would be handled with light cranes and which might easily drop from trucks and the like in handling. Still further brackets of 1000 to 10,000 lb. would be handled by heavier equipment and would be subject probably only to a dropping hazard and this drop would be of a very short distance.

Still another bracket is contemplated for packages of 5 lb. or less which might be handled in mail bags. These packages might be thrown considerable distances and might possibly drop considerable distances. All of this indicates that some degree of change in the performance standards might be expected according to the weight of the package itself.

There are five principal tests which have been employed as performance tests for containers in shipping and warehousing. Naturally the drop test, as has been indicated in the discussion of weight classification, is one of these. Other tests include tumbling in a revolving drum, travel down an inclined plane which would simulate to some degree action inside a freight car in sudden acceleration or deceleration, a vibration test, and a compression test.

In the case of the drop test there are three principal manners in which tests are conducted. Some packages are tested by allowing them to drop on one face only, this being usually the bottom of the package. While no decision has been reached it is probable that such tests would be confined to heavier packages which would not be tumbled and which might drop only short distances. In conducting this test there are two principal methods, one being a cycle of a prescribed number of drops at one level only. Another, commonly called the progressive method, would involve dropping from a moderate height for a certain number of falls, usually ten, followed by the same number of drops at a slightly greater height and so on until visible damage to the package or to its contents occurs. Progressive, as well as fixed level testing, is used also for some of the other tests covered later.

Another type of testing by the use of the drop method involves dropping on the six faces on the package, one after the other at a prescribed level. No set regimen of testing has been specified for such drops but it is contemplated that if such testing is used in performance aspects, a stated order of testing the faces would be adopted.

Still a third and perhaps the most important method of using the drop test is to follow a plan of dropping first on one of the corners, then on three of the edges and finally on the six flat faces. It has already been suggested and to some extent adopted in test specifications that the following would be the order of such drops.

1. One drop on one of the corners which includes the top face of the package. In the case of corrugated containers, this corner is the one which contains the manufacturers joint, such as stapling or taping.
2. One drop on the shortest edge leading from that corner.
3. One drop on the medium length edge leading from that corner.
4. One drop from the longest edge leading from that corner.
5. One drop on one of the smallest faces.
6. One drop on the opposite smallest face.
7. One drop on one of the medium faces.
8. One drop on the opposite medium face.
9. One drop on one of the largest faces.
10. One drop on the opposite largest face.

It is quite probable that the last described dropping method will be used for the smaller and medium weight packages and that a single face method will be used for the largest packages in terms of weight.

A second type of testing by the drum involves tumbling inside a hollow, 6-sided drum with specified hazards and obstructions inside that drum. There are two common sizes of drums, one being the 14-ft. drum for the large-size packages and the second being the 7-ft. drum for medium-size packages. In the case of very small packages a newly developed drum, identical in most respects but of $3\frac{1}{2}$ ft. in diameter has been employed but has not yet become standard.

In all cases of the use of the drum the test starts on a specified face of the drum and with the box placed on that face in a specified position. A very slow rotation is employed which allows the package to be carried part way up on the side of the drum and then to fall freely until it strikes an obstruction and comes to rest, when it is again carried forward. Since the drum is made with six sides, each side will result in a drop or in a "fall." The number of falls will be specified for the package as a performance standard.

A third testing devise is the inclined plane or conbur test. This test was developed by the Freight Container Bureau of the Association of American Railroads and the first syllable of the word "container" followed by the first syllable of the word "bureau" has been used for the name of this test. The inclined plane has an angle of not quite 10 deg. The plane is equipped with a dolly which can roll freely down the plane and on which the package is placed. The dolly and the package roll down against a fixed back stop where both are brought to an abrupt stop. Release of the dolly from a distance of about 1 ft. up the incline is equivalent to between 4 and 5 miles per hour, from 2 ft. is equivalent to 7 miles per hour, and

from 3 ft. is equivalent to 9 miles per hour, in the change of speed of a railway car to which the test may be compared.

To some extent the conbur test was developed as a substitute for the drop test and it is perfectly possible to place containers on the dolly in such a position that any of the faces, any of the edges, or any of the corners may be impacted. Much of the testing using the inclined plane, however, is with one face, or at the most the six faces, of the package striking the back board. The drop test can be used to substitute for all of the variables that might be encountered and tested on either of the devices, so far as applying to drop hazards is concerned.

A newer test of recent development is the vibration test. This may or may not be considered a test in itself as in many cases a certain time of vibration is used to precondition a package for testing on other devices. Thus vibration can shake an item inside the container loose from its supports. It would be possible that a package might more readily fail if first vibrated and then given a drop, drum, or conbur test. The test, however, can be considered of considerable value in itself, in that in the case of items placed in crates, the visible loosening of the supports or damage to the article would show up in the vibration cycle alone.

There are many possible combinations of vibration. One of the most common depends upon the eccentric action of a platform which is supported by two shafts. The shafts turn at different speeds and are connected to the platform by eccentric cams. This gives a change in the period and type of vibration which is valuable for the purpose of the test. The force given to the package can be described in "*g*'s;" thus a force is said to be "one *g*" if the vibration is such that the package just barely leaves the platform during the vibration cycle. Vibrations on such a machine are specified from thirty minutes to two hours in length of time.

A fifth test is the compression test particularly adapted for containers which must protect the inner content from any type of external load. Compression testing is usually done by subjecting the package to squeezing action between two flat plates. Both the load and the amount by which the package is compressed are measured. A common designation is that the package must show a resistance of some specified number of pounds before it has been compressed 0.75 in. Obviously compression testing is given to packages such as corrugated paper, fiberboard, or light wood boxes. It is not usually given heavy sheathed crates or the like.

With these five tests, we believe that some consideration must be given to the type of service that a package is expected to give. We believe that the easiest type of handling is that involved in a full carload or a full truckload shipment from manufacture to ultimate destination. A considerable quantity of goods moves in this fashion, and the requirements for such service are much less than for the second grouping which includes: less than carload, less than truckload, airmail, express, and the like. A third classification of shipping hazard is commercial export, and the fourth and final classification is military export.

A further classification of packages is based upon the contact between the package and its content. In one classification "easy" loads are considered to be those in which the entire inner surface of the container is in contact with the contents. In a medium load there is a partially complete contact. In a difficult load there is very little contact between the package and its content as would be given by irregular shapes, and a fourth classification of concentrated load is now being advocated for those packages which have very heavy contents in which there may be contact between these contents and the container over a very small area. Steel bars in an external package would be one type of the concentrated load.

While Subcommittee IV of A.S.T.M. Committee D-10 has not reached the point of specifying performance standards, a group in the Porcelain Enamel Institute has adopted specific provisions for their products. They have specified three weight brackets and two tests, including the vibration test and the conbur or inclined plane test, the latter being substituted for by a drop test on the lighter packages.

As an example for packaged products from 100 to 1000 lb. weight, they first specify a vibration at 1 *g* acceleration for one hour to be followed by a conbur test on each face and the bottom, impacted from what is called the "5th zone." This is usually equivalent to about a 3-ft. drop on the conbur. The use of this terminology refers to a standard impact recorder which is in position on the package being tested.

For packaged products under 100 lb. but over 50 lb. weight, vibration for one hour is followed by either dropping on one corner, the three edges, and the six faces as already mentioned from a height of 12 in. or from 72 in. on the conbur test. If the package weighs under 50 lb., the drop test alone is used from either 12, 18, or 24 in. according to the product. This gives some indications of what might be expected in the way of designation of performance standards, but only two tests have been adopted by the Porcelain Enamel Institute.

It is possible that Subcommittee IV will follow this lead on the vibration test, although there is some tendency to go to a 30-min. test for full carload type of shipment hazard, a 45-min. to 60-min. test for less than carload, a 90-min. test for commercial export, and 120 min. for military export. One member has advocated 12 falls on a 14-ft. drum or full carload shipments, 18 for less than carload shipments, 36 for commercial export, and 48 for military export. Those using the 7-ft. drum have so far indicated, only, that 30 falls should be used for full carload shipments. Since it is generally considered that a 14-ft. drum is $2\frac{1}{2}$ times as severe as the 7-ft. drum, it would probably follow that 45 falls would be specified for less than carload lots, 90 falls for commercial export, and 120 falls for military export. All of these figures for the drum test are given as indication of some of the thinking involved and not as decisions of the committee.

From the foregoing it is evident that a great deal of work must be done. The fact that a test can be developed which would imitate certain of the types of damage found in shipping does not necessarily set this test up as one which should be employed without some knowledge as to the performance level involved. It is not considered economic that a package be so developed that it would give full and complete protection to its contents in any kind of shipping. There might be just as much economic loss in terms of unnecessary expense from overpackaging as by underpackaging where some of the contents might be lost. This is the reason for careful consideration of performance standards and is the reason why the committee is taking considerable time for its deliberations.

For this reason, also, the committee would welcome the thoughts of anyone who has adapted a test of some type of performance to a shipping hazard. Suggestions can be sent directly to the author or to the Secretary of A.S.T.M. Committee D-10, Earl Stivers of the Package Research Laboratory, Rockaway, N. J.

What I have tried to do is to show how widespread are the ramifications of testing in relation to handling and shipping. All types of hazards are involved such as dropping, tumbling, throwing, vibration, and load bearing. All must be considered. Our goal is that in the end a shipper can have assurance that his packaged goods may be shipped safely and also economically, to their ultimate destination.

Method for Weight Loss of Plastic Films and Sheets on Heating*

By Maurice E. Marks[1]

THE loss of plasticizers or other volatile ingredients from vinyl film and sheet is of much concern to the producer of such material, since such losses result in stiffening and generally poor quality. Consequently a number of accelerated tests have been developed for determining this volatile matter. Usually a temperature sufficiently high to give significant losses in about a week or less is chosen and the losses are determined from day to day or after a one-week period. Comparison of total loss and of the rate of loss helps in understanding the differences between plasticizers. However, a number of other factors are also of importance and they must be carefully controlled. One very important property of plasticizers in vinyl films is their tendency to transfer from one specimen to another when tested in close proximity. This is of special importance when films containing plasticizers of widely different volatility rates are being tested. In no case can such materials be heated exposed to each other in the same oven, because erroneous results will always be obtained due to this transfer of the plasticizers from one film to the other.

Therefore, as has been generally recognized, special equipment is necessary for obtaining useful and accurate data. A number of laboratories have developed special ovens and special techniques to solve the problem. For example, M. C. Reed[2] has developed an oven consisting of a number of chambers through which heated air is passed at a constant rate. Each chamber during a test contains films of only one type. The A.S.T.M. has issued a tentative method[3] which involves an Abderhalden dryer through which preheated air is passed. Another version of this method has been developed in England.[4] Although all of these methods are suitably designed for the problems involved, it was felt that for routine testing where

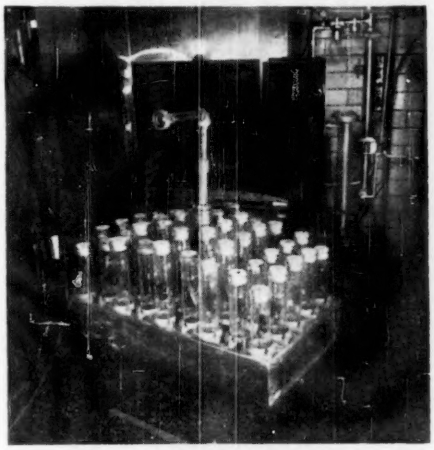

Fig. 1.—Volatility Apparatus.

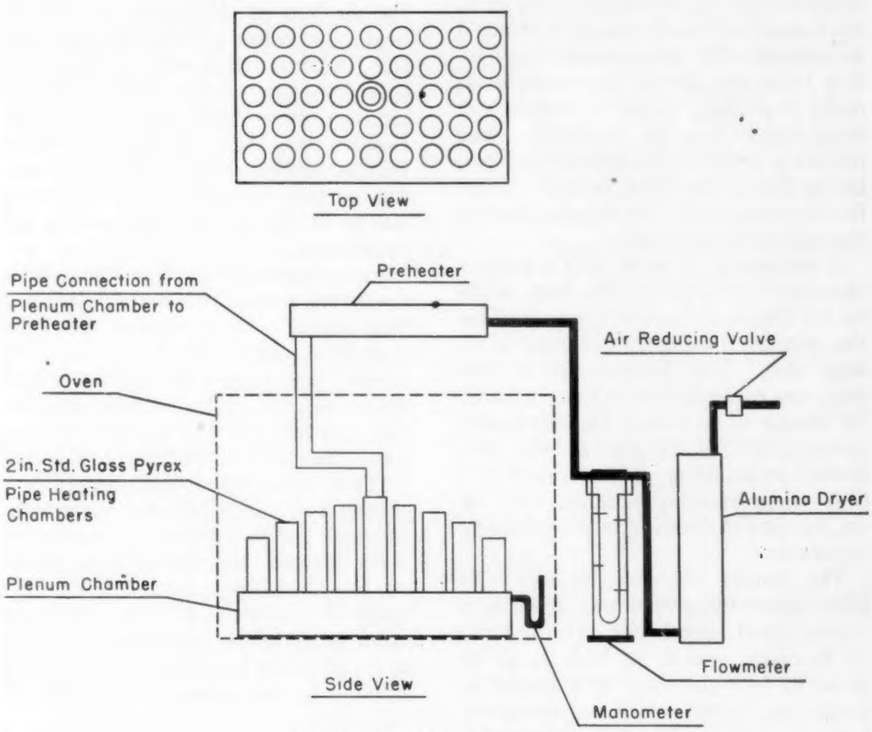

Fig. 2.—Volatility Apparatus.

large numbers of samples must be tested by nontechnical personnel, a different approach was needed. For example, the Reed apparatus which is a large specially designed oven, would be costly to construct and the number of separate chambers is inadequate when a large number of samples were to be tested. The A.S.T.M. method and its English counterpart are excellent for research purposes but are not suitable for routine testing. They are inadequate for multiple setups because of the necessary complexity of temperature and pressure controls.

Consequently, there appeared to be a need for an apparatus that would be reasonably low in price, would allow testing large numbers of samples with each specimen in a separate chamber and which would be easily controllable especially from temperature, air pressure, and rate of air flow standpoints.

Apparatus

After considering the requirements of the test, the following were listed:

1. A multiple-chambered apparatus convenient to use and inexpensive to make.
2. A source of preheated, clean, dry air.

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[2] *Industrial and Engineering Chemistry*, Vol. 35, p. 896 (1943).

[3] A.S.T.M. Tentative Method of Test for Weight Loss of Plastics on Heating. (D 948 – 47 T), 1947 Supplement to Book of A.S.T.M. Standards, Part III-B, p. 192.

[4] *Journal*, Soc. Chemical Ind., January, 1947.

3. A method for metering the air, at various constant rates from 5 to 500 in. per min. to each chamber.

After several ideas had been tried, the first two considerations were met in the manner shown in Figs. 1 and 2 by fastening standard pyrex pipes to a rectangular box in which holes were cut. The assembly was placed in a large circulating air oven and heated air passed over the samples by utilizing the laboratory air lines (Fig. 2). The air was first dried by an alumina dryer and then heated by an internal electric heater controlled by a thermostat. Since the oven was also kept at the desired temperature, very even heating resulted.

The third requirement presented considerable difficulty since it was first believed that each of the tubes would have to be separately metered by flowmeters—a complex and formidable problem. Careful consideration of the situation, however, indicated that it could be solved by placing a disk containing a small hole at the bottom of each tube and applying suitable constant pressure in the plenum chamber to obtain the desired rate of flow through each orifice. Tests made on the apparatus with various size orifices and pressures were conclusive and showed that constant air rates through all tubes could be obtained.

Since the apparatus described above is composed of a number of identical units, the number of chambers may be changed to conform with the particular application being considered—for example, to make it possible to use a certain size oven which may be available. The following details of the apparatus shown in Fig. 2 may, therefore, be easily modified to correspond to the requirements of the individual laboratory.

A circulating air oven with a heating chamber 3 by 3 ft. by 2 ft. deep, made by the Despatch Oven Co., was used for the primary heating unit because of its large size. The temperature of this oven was controlled to at least ±0.5 C. by means of a Cenco De Khotinsky thermostat. A damper in the side limited recirculation of the air to 90 per cent when running without any air coming into the oven from the volatility apparatus.

The plenum chamber for the volatility apparatus proper was made as a welded sheet metal box, 34 in. long, 22 in. deep, and 6 in. high so as to fit easily into the oven with plenty of working space in front of and above the apparatus. Forty-four 2-in. holes properly spaced were cut in the top of the box, and around each, three threaded studs were welded. These latter were used for fastening standard flanges to the 44 standard pyrex pipes. It was found that 9-in. pipes were of a suitable length although Figs. 1 and 2 show a number of sizes because of their availability.

Air was supplied to the plenum chamber by a 1-in. pipe line coming through the top of the oven and entering into the center of the apparatus as shown in Figs. 1 and 2. The air from the laboratory line was first passed through a 4-ft. vertical section of 2-in. pipe to remove oil and water and then through a reducing valve to an alumina dryer. For this drying, a commercial Lectrodryer or a 4-ft. 3-in. pipe column containing alumina can be used. The amount of air supplied to the plenum chamber was metered by a calibrated capillary tube flowmeter.

Because of the high velocity of air flow, the problem of preheating of the air was important. After several methods were tried, a method of internal direct heating was used. The air was passed through a 3-ft. section of the standard 2-in. glass pipe within which was placed a 500-w. nichrome wire coil mounted on a glass stand made from glass rod. This was arranged in one unit so that it could easily be replaced. The voltage on this heater was adjusted so that the heat developed was slightly greater than that needed to keep the air entering the oven at the required temperature, which was usually either 60 C. or 100 C. A thermostat was placed in the air line at the outlet end of the heater just before entering the oven, and this, in conjunction with a relay, controlled the temperature of the air entering the oven to the desired temperature. Besides this, the oven itself was carefully controlled at the desired temperature so that the entering air remained always at this temperature as also did the sample.

As explained above, 2-in. metal disks containing a small hole centrally located were placed at the bottom of each tube in order to control the rate of air flow. It was found experimentally that with a certain pressure in the plenum chamber and a certain size orifice a definite constant rate could be obtained at all tubes. In Table I are listed approximate data obtained in this particular apparatus. However, for an accurate determination of the flow rate, the amount of air entering the chamber as read by the flowmeter should be used. The linear velocity given in the table was calculated by dividing the total flow rate by 44 and dividing by the cross-sectional area of each tube.

TABLE I.—AIR-FLOW DATA.

Linear Velocity, in. per min.	Plenum Chamber Pressure, in. water	Orifice Diameter, in.
315[a]	11	0.217
270[a]	11	0.217
81[b]	3	0.197
14[b]	0.1 (approx.)	0.059
7[b]	0.1 (approx.)	0.059

[a] Six-tube apparatus.
[b] Forty-four-tube apparatus.

Method

The method to be used for running volatility tests on films may vary depending upon the purpose of the test. In this laboratory two methods have been employed differing essentially in sample size, in temperature, and in air rate. They are outlined below.

Film Tests:

Three-inch disks of the film, usually 4 mils thick, are died out and conditioned for 1 hr. in the apparatus at 60 C. and 14 in. per min. air rate. The specimens are hung in the center of the tubes from paper clips by means of a wire stand. Only one specimen is used for each chamber. After conditioning, the specimens are weighed and replaced in the tubes. In the routine test, the specimens are weighed after one week. This is done immediately after cooling at 25 C. in a desiccator containing calcium chloride. For research purposes, the specimens are usually weighed daily and the loss noted on a graph.

Sheets Tests:

Dumbbell-shaped specimens of the sheet which are usually 75 mils thick are died out and then conditioned at 25 C. for 24 hr. in a desiccator containing calcium chloride. They are then placed one to a tube in the apparatus and heated at 100 C. for four days at an air rate of 60 in. per min. At that time they are removed, cooled to 25 C. in a desiccator containing calcium chloride and reweighed. Stress-strain tests are then run on the specimens if desired.

Precision of Test

In Table II are shown successive data obtained on a single plasticized vinyl film material (the formulation was 100 parts of Geon 101 and 50 parts of plasticizer). The precision is quite good especially when the small losses are considered. Tests made over several runs show the same precision. It is almost always possible to check results on the same sheet of resin to a few tenths of a per cent actual loss even though the tests are started at different times. Because the results agree so well regardless of the position in the apparatus it may be said that the important variables of temperature and air flow are being held constant. Attempts were made without too much success to measure the air rate in the separate chambers. However, flowmeter measurements made with very small pressure heads showed the same rates at all tubes even though

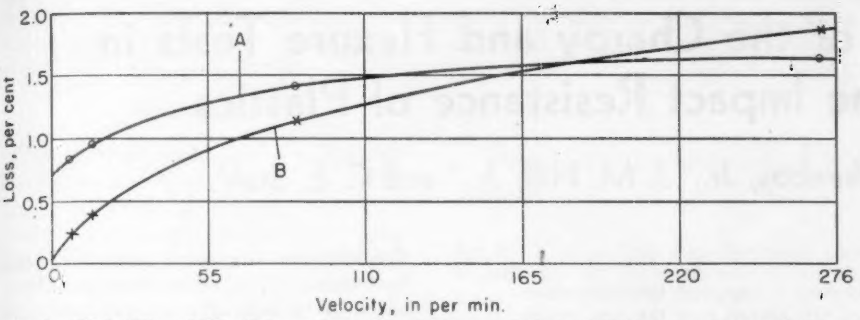

Fig. 3.—Volatility of Plasticizers from Vinyl Films. Effect of Velocity. (Data Obtained at 240 hr.)

TABLE II.—PRECISION OBTAINED IN VOLATILITY TEST.
(Velocity = 14 in. per min.)
(Temperature, 60 C.)

Specimen	Loss, per cent	Deviation from Average
No. 1...........	1.61	0.08
No. 2...........	1.58	0.05
No. 3...........	1.60	0.07
No. 4...........	1.62	0.09
No. 5...........	1.60	0.07
No. 6...........	1.57	0.04
No. 7...........	1.57	0.04
No. 8...........	1.53	0.00
No. 9...........	1.54	0.01
No. 10...........	1.68	0.15
No. 11...........	1.64	0.11
No. 12...........	1.57	0.04
No. 13...........	1.47	0.06
No. 14...........	1.46	0.07
No. 15...........	1.39	0.14
No. 16...........	1.51	0.02
No. 17...........	1.38	0.15
No. 18...........	1.53	0.00
No. 19...........	1.51	0.02
No. 20...........	1.41	0.12
Avg...........	1.53	0.06

the readings were slightly inaccurate. Temperature measurements were constant throughout the apparatus.

Experimental

It was noticed during these tests that the amount of volatile loss was greatly dependent on the rate of air flow past the specimens. Ideas differ as to the proper rate to be employed. For example, Reed recommends 18 changes of air per minute, the A.S.T.M., one change per minute. Two factors are present. At high rates of air flow, the plasticizer is removed from the film surface as rapidly as it diffuses from the inside of the film. The controlling factor at high air speeds is, therefore, the rate at which plasticizer diffuses from the interior of the film to the surface (so-called solid diffusion). At low air speeds where a concentration of plasticizer can build up near the surface of the film, the controlling factor is the vapor pressure of the plasticizer at the temperature employed. These phenomena were readily observed in these tests. As shown in Fig. 3 where the volatile loss at a fixed time of 240 hr. is plotted against the air velocity, a curve is obtained which shows the dependency on velocity. Film *A* contains a plasticizer which at first shows a higher dependency than *B* on velocity but this is reversed after the air velocity reaches about 180 in. per min.

Another item of considerable interest involves a comparison of the time-loss curves for two plasticizers in vinyl films. Reference to Figs. 4 and 5 illustrates very clearly that these two plasticizers have very different volatility characteristics. At low rates of air flow (Fig. 4) the total loss is much less for plasticizer *A*. At high rates (Fig. 5) *B* at first volatilizes faster than *A* but after about 130 hr. volatilizes very slowly. Eventually *A* even evaporates faster than plasticizer *B*. The indication is that plasticizer *B* has a small amount of relatively easily volatile matter in it which comes off first, but that afterward the residual plasticizer is much less volatile than *A*.

Conclusion

Since the apparatus was designed primarily for routine operation, it was tested in this laboratory over a period of time using nontechnical personnel. As far as the physical apparatus is concerned, very little trouble occurred. When the apparatus is properly assembled, the air rate and temperature can be controlled for long periods of time and need only an occasional check. The routine technicians were able to obtain consistent results over a year's period without difficulty.

Acknowledgment:

Most of the construction and experimental work in this project was carried out by Mr. William Montgomery, who also suggested the use of standard glass pipes for the heating chambers.

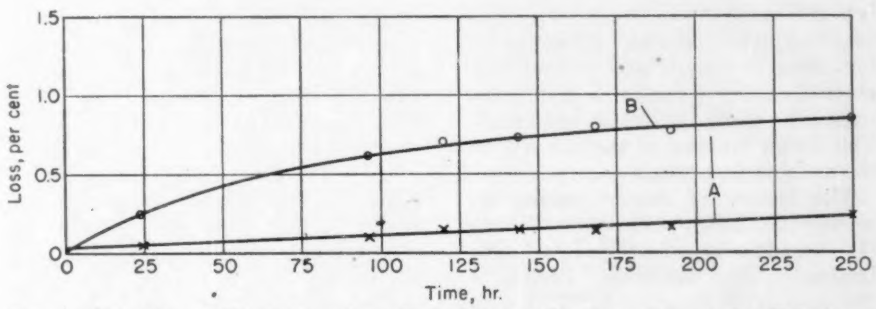

Fig. 4.—Volatility of Plasticizers from Vinyl Films. Temperature—60 C. Velocity—7 in. per min.

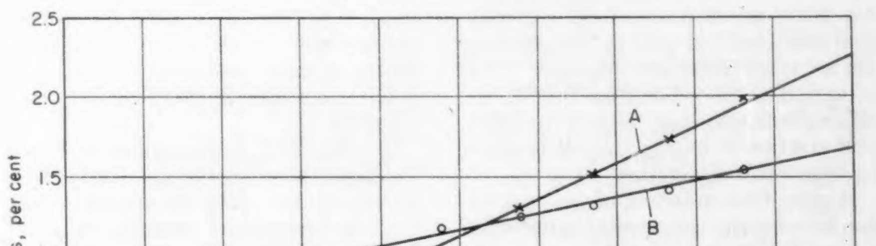

Fig. 5.—Volatility of Plasticizers from Vinyl Films. Temperature—60 C. Velocity—81 in. per min.

The Significance of the Charpy and Flexure Tests in Evaluating the Impact Resistance of Plastics[1]

By H. M. Quackenbos, Jr.,[2] J. M. Hill, Jr.,[2] and C. E. Staff[3]

Synopsis

A Charpy impact test can be made in such a way that the extraneous energies (end-effects and machine losses) are absent and the test result represents only the energy to break the specimen. This test result has been determined for notched and unnotched bars of thermoplastics and laminates at various velocities of impact and has been compared with the area under a load-deflection curve in flexure. Between 0 and 4 ft. per sec. there may be a great change in energy to break, but the effect of velocity is slight in the practical impact range (between 4 and 11 ft. per sec.). Energy to break involves separation into two pieces but damage by cracking or deformation may often precede such separation. Such energy for damage can sometimes be best deduced from a flexure test. Possible impact testing methods for all plastics are considered in the light of these findings taken in conjunction with present knowledge of the thermosetting plastics. Two procedures are commended over the present Izod test, and both notched and unnotched bars should be used in each: (*a*) a Charpy test, (*b*) a Charpy test for some materials and a flexure test for others.

The impact test is considered one of the most important tests for plastics both for permitting quality control and for providing design information. In quality control the aim is to determine the uniformity of production of a given material. By design information is meant here a prediction about the relative toughness of different materials under practical conditions. The design function of the test will be the main subject of this paper.

The history of impact testing for plastics goes back to 1926 when Werring (**1**)[4] introduced specially designed light Izod and Charpy machines. Both have remained in the standard A.S.T.M. procedure without change up to the present time. However, over the years the Izod test has come to be used almost to the exclusion of the Charpy. About ten years ago it was realized generally that the Izod test and field experience did not place materials in the same order of impact merit. There has been a vigorous discussion since of how to interpret and how to modify the test in order to reduce this disagreement.

A good understanding of past papers can be gained by comparing the test with a practical situation in which a plastic object, say a telephone receiver, is falling to the ground. Similar considerations hold when a stationary plastic object is struck. This comparison follows:

1. In the Izod test the result impact is generally acknowledged to consist of three different energies: (*a*) to throw the broken end, (*b*) to deform the machine base, (*c*) to deform the specimen. The first component has no equivalent in the practical situation and should be eliminated. There may be a practical equivalent to the second component of energy in that there is a partition of energy between the falling receiver and the surface that it strikes. However, the proper procedure is to isolate the third component, the true energy to break. This is, of course, the area under the impact load-deflection curve.
2. The Izod test bar is always notched whereas the molded object may or may not contain notch equivalents (holes, corners, or screw threads). A notch may reduce impact resistance several-fold.
3. The test temperature is fixed. Temperature will not be discussed in this paper. It can easily be arranged that the test temperature be in the range of field temperature.
4. The Izod test is always made at an approach velocity of 11 ft. per sec., whereas the molded object may encounter a range of impact velocities. This is important because if impact resistance is sensitive to velocity the test result at one velocity can be used only with limited confidence.
5. In the Izod test the specimen is always separated into two pieces. If the falling receiver were made of certain materials it would be rendered unfit by a crack or by excessive permanent deformation after a shock not nearly severe enough to cause separation into two pieces.

From the above four points, omitting temperature, it is seen that the problem is one of determining the effect of several variables on the energy given by the area under the impact load-deflection curve. These are: velocity, the notch, cracking, and large permanent deformation.

There has been considerable progress in solving this problem for some brittle plastics such as the phenolic compounds. With the thermoplastics and laminates, on the other hand, there is still almost complete darkness. Recent contributors to the knowledge of brittle plastics have been Kuntze and Nitsche (**2**), and their collaborators and successors, Callendar (**3**), Hazen (**4**), Telfair and Nason (**5**), Marks (**6**), Welch and Quackenbos (**7**), Liander, Schaub, and Asplund (**8**), and Koon (**9**). The true impact (load-deflection) energy has been isolated in two ways. First, a drop-weight machine was used (**3, 6, 8**) in which the energy of the falling weight is just enough to break the specimen and there is no end-effect. In the machine used by Marks the energy lost to the machine base was deduced to be zero. In the other machines it was probably not great. Second, the stress-strain curve (and hence the load-deflection curve) was measured under impact conditions (**7**). A conclusion of this last paper was that in the Izod test an astonishing amount of energy, several times that needed to break the specimen, was lost in the machine base.

It is believed that a majority of the above writers would agree that: (*a*) both notched and unnotched bars be used for impact tests, (*b*) there is a need for considering the true impact energy as a load-deflection energy and correlating it with the similar energy in a flexure test, and (*c*) velocity effect is slight with brittle materials between 0 and 11 ft. per sec.

The information on brittle materials is fairly complete. The aim of this paper is to supplement the meager knowledge of the impact loading of thermoplastics and laminates. As before, this involves a determination of the true (load-deflec-

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Presented at the meeting of Subcommittee VIII on Research of Committee D-20 on Plastics at Atlantic City, November 17, 1948.

[2] Research Engineer and [3] Assistant Superintendent of Research and Development, Bakelite Corp., Bloomfield, N. J.

[4] The boldface numbers in parentheses refer to the list of references appended to this paper.

tion) impact energy and its connection with velocity of impact, notching, cracking, or large permanent deformation and with flexural energy to break.

Procedure

The methods followed were: (1) to investigate the load-deflection curve in impact loading; (2) to measure an impact energy under such conditions that the extraneous energies (end-effect, base-loss) were absent or negligible. This involved an investigation of such conditions; (3) to make flexure tests and calculate an energy from the area under the curve of load *versus* deflection.

1. Load Deflection Curve.—The attempt to measure the impact load-deflection curve was based on the method previously described in detail for the phenolic materials (**7**). The dynamic modulus defines the linear portion of the stress-strain curve and the same portion of the load-deflection curve. The dynamic modulus was determined with a specimen bearing an SR-4 electric strain gage (**10**) connected to an amplifier and an oscillograph. The specimen was held lightly in the fingers at one end and was rapped at the other to set it in natural vibration, and the oscillations in strain shown by the gage were photographed as they appeared on the screen of the oscillograph. From the frequency of vibration, modulus of elasticity was calculated according to:

$$w = \frac{22.4}{L^2}\sqrt{\frac{EI}{u}} \qquad \text{(1)}$$

where:

w = frequency, cycles per second,
b, h, L = breadth, depth, and length, respectively,
I = moment of cross-section, $bh^3/12$,
E = modulus of elasticity, and
u = mass per unit length.

This dynamic modulus was compared with the flexural modulus, determined as in Eq. [illegible] later.

In conjunction with the strain the dynamic modulus determines the stress-strain curve (usually linear to failure) for the phenolic materials. However, many thermoplastics and laminates depart from such linearity near failure and both load and strain must be measured simultaneously for a complete definition of behavior. The circuit of Fig. 1 was applied to the problem. The electric gage on the specimen, indicating strain, was connected through an amplifier to the X axis of the oscillograph. The two gages on the curved, easily deformed supports were connected in series through another amplifier to the Y axis. These latter gages indicated the load applied and were calibrated in a separate flexure test, on the assumption that the spring steel of the supports had the same properties under slow and fast loading.

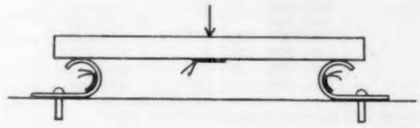


Fig. 1.—Electric Gages on Specimen and on Supports for Measurement of Impact Stress-Strain Diagram.

2. Impact Energy.—An analysis was first made of the Charpy machine to determine those conditions under which end-effects and base-losses are absent or negligible. End-effects were investigated essentially by the method first described by Telfair and Nason (**11**) in which the energy to break at a very low pendulum angle is compared with that at the usual maximum angle, and the difference is taken as end-losses. This method is good only when the energy to break the specimen and energy to deform the machine base are constant, a condition supposedly correct with the specimens of thermosetting molding material used here. Machine losses were examined by measuring the strain in a specimen struck gently by the hammer, from a lowered position, so that there was no fracture and so that the strain was well within the elastic limit established in a flexure test. Strain was measured, as described above, with an SR-4 gage located centrally on the face in tension. Energy losses to the machine were taken as the difference between the energy in the hammer and that (U) appearing in the specimen calculated from the measured strain according to the accepted formula for elastic conditions:

$$U = \frac{1}{216} EbhL\,\epsilon^2 \left(1 + \frac{3h^2}{L^2}\right) \ldots \text{(2)}$$

where:

b, h, L = breadth, depth, and span, respectively,
E = dynamic modulus of elasticity, taken equal to the flexural modulus for the same specimen (see Eq. 3),
ϵ = maximum strain = measured strain $xL/(L - l/2)$ where strain is assumed to increase linearly with distance from the supports, and
l = length of SR-4 grid, usually $\frac{1}{2}$ in.

The strain was usually the mean value of four or five visual determinations with an average departure from the mean of 3 per cent. As strain occurs as a squared quantity to give U, the percentage for U is $\pm$ 6. This discussion omits the error introduced when the dynamic modulus was taken equal to the flexural modulus.

With specimens only $\frac{1}{8}$ in. thick, the SR-4 gage stiffens the specimen and the value of U must be multiplied by the factor: load-strain modulus divided by load-deflection modulus for the specimen when bearing the gage.

Next the impact strength was determined at various velocities in the Charpy machine for thermoplastics and laminates mainly under those conditions for which end-effects and base-losses were negligible. The impact strength was then virtually an energy consumed only in breaking the specimen. Velocity was varied simply by varying the angle of swing of the pendulum.

Many impact machines allow the pendulum to be released from one point only and they are calibrated only for that point. An easy way of lowering the release point is to twist one end of a piece of copper wire around the catch on the pendulum and make the other end into a loop which can fit over the release stud. When the stud is withdrawn by the release mechanism, the pendulum (and wire) swings through. This is a surprisingly reproducible method as shown by the constancy of free swing. If the friction nut on the specimen has been adjusted so that the full free swing gives the proper reading, the values for a lower swing can be calculated as follows (for a 2 ft-lb. machine having a velocity of impact of 11 ft. per sec.):

Free swing from usual position, pointer carried	0.060
Above repeated, but pointer carried from 0.060	0.032
Therefore, windage correction, half swing 0.032/2 =	0.016
From lowered position, suppose free swing, pointer carried	1.381
And given correction for 1.381	0.036
Then energy at impact for free swing of 1.381	
2.000 − 0.016 − 1.381 + 0.036 =	0.639 ft-lb.
Suppose a specimen is broken with this reduced swing and reading is	1.945
And given correction for 1.945	0.023
Then impact strength is	
1.945 − 0.023 − 1.381 + 0.036 =	0.577 ft-lb.
And average velocity during impact is $11 \times \sqrt{\frac{0.639 - 0.577/2}{1.984}}$ =	4.6 ft. per sec.

3. Flexure Tests.—Flexure tests on specimens similar to those used in the Charpy experiments were made in the usual manner in which load and deflection are recorded simultaneously. In all these the crosshead motion was con-

TABLE I.—DYNAMIC AND STATIC MODULI FOR PLASTICS.

Material[a]	Dynamic Modulus,[b] psi.	Static Modulus,[c] psi.
Cellulose acetate	340 000	290 000
Vinyl chloride-acetate	500 000	440 000
Polystyrene	480 000	460 000
Experimental thermoplastic	610 000	560 000
XXX laminate (cresol resin + paper)	1 160 000	1 110 000
L laminate (phenolic resin + cloth)	1 020 000	1 100 000
X laminate (phenolic resin + paper)	1 180 000	1 230 000
Fiberglas laminate (phenolic resin)	2 200 000	2 600 000
Acrylic resin	680 000	490 000

[a] All specimens ½ × ½ in. in section, compression molded if thermoplastic.
[b] Dynamic modulus was calculated from Eq. 1 and is the mean of between two and four determinations. Average deviation from the mean was 3 per cent.
[c] Static modulus from flexural load-strain readings on the same specimens used for dynamic modulus, as in Eq. 3. The result is the mean of two determinations normally not differing by more than 2 per cent.

tinued until the specimen was severed or until the load was reduced to not more than two or three pounds. With several materials this meant that the test was continued long after the maximum load was reached and the load had fallen to a low level while a crack was being propagated. Great care was taken to note the first appearance of cracks. Area under the flexural curve, both for cracking and for severance, was determined with a planimeter and converted to foot-pounds.

Flexural modulus was also calculated from readings of strain *versus* load. The SR-4 electric strain gage was centrally located on the tension face. If the average measured strain was ϵ for a given increment of load P:

$$E = \frac{\text{max. stress}}{\text{max. strain}} = \frac{1.5PL}{bh^2} \times \frac{(L - l/2)}{L\epsilon} \quad \ldots . (3)$$

Results

The Load-Deflection Curve in Impact Loading:

A comparison between the dynamic and static modulus for thermoplastics and laminates appears in Table I. The two moduli are approximately the same, indicating that, at low stresses, the stress-strain path is the same in both static and impact loading. The attempt to measure the load-strain relation over the whole range of stress to failure was unfortunately unsuccessful. The screen of the oscillograph, when the Y axis was arranged to indicate load and the X axis strain, showed only a ragged S-shaped curve, even with thermosetting materials having a linear stress-strain curve to failure.

The measurement of breaking strain alone on the X axis was a failure with the laminates and injection-molded thermoplastics because: (1) if the deformation is large the SR-4 gage may be strained past its measuring limit, (2) the gage is difficult to bond to some thermoplastics, especially polymers of styrene, and (3) the surface of some laminates may crack long before the bar is severed. As soon as this happens the electric gage is broken and no further record of strain is given.

As it was not possible to obtain curves of load and deflection under impact loading, another way of reaching the true impact energy to break had to be tried. The first step was to discover those conditions under which the Charpy impact strength is essentially equal to the true impact energy and extraneous energies are absent.

Energy Distribution in the Charpy Test:

The other impact tests might have been examined. The Izod test was ruled out, however, because energy losses seemed hopelessly high (7) and the drop-weight machine was excluded because the method is tedious and large numbers of specimens are needed.

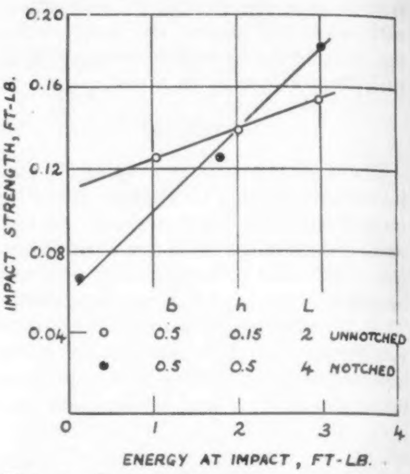


Fig. 2.—Impact Strength *versus* Energy of Charpy Pendulum at Impact for Phenolic Resin-Woodflour Material.

The end-effect decreases with the volume of the ends thrown. The phenolic wood-flour combination was chosen because it shows the greatest end-effect among the phenolic materials having a density close to 1.3.

The proportion of energy absorbed by the specimen in Table II rises in general with increasing flexibility of the specimen, that is, with a rise in $L^3/4Ebh^3$ (symbols as in Eq. 2). This has been discussed more fully before (7). With specimens ½ in. square, machine B (the standard Baldwin-Southwark machine) allows a higher proportion of energy to be absorbed by the specimen than machine A, probably because it is of heavier construction. An important conclusion from Table II is that energy loss to machine A is zero with specimens ¼ in. thick on a 4-in. span and is small with ⅛-in. specimens on a 2-in. span.

A detailed analysis of end-losses will be made before this conclusion will be discussed.

TABLE II.—ENERGY DISTRIBUTION IN THE CHARPY MACHINE.

Material	Breadth, in.	Depth, in.	Span, in.	Energy to Specimen, per cent[a]	Energy to Machine, per cent[a]	Approximate End-Effect, ft-lb. per ft-lb.[b]
Machine A						
Paper laminate	0.5	0.5	4	73	27	0.040
Cloth laminate	0.5	0.5	4	71	29	...
Polystyrene	0.5	0.5	4	70	30	...
Phenolic-fabric	0.5	0.5	4	72	28	...
Phenolic-mica	0.5	0.5	4	81	19	...
Seven phenolic materials having different fillers	0.5	0.25	4¼	102 (mean) 94 to 110 (range)	0	...
Thermoplastic:						
Polymer A	0.25	0.5	4	116	0	...
Polymer B	0.25	0.5	...	104	0	...
Eight materials covering laminates, rigid thermoplastics and a thermoset	0.5	0.125	2	88 (mean) 76 to 102 (range)	12	0.015
Machine B						
Thirteen materials covering rigid thermoplastics, laminates, phenolics, urea materials				86 (mean) 72 to 103 (range)	14	...

[a] Elastic non-fracture of unnotched bars with end-effect excluded. Approach velocity of hammer was in the range 1.3 ft. per sec. to 3.4 ft. per sec.
[b] Estimated in a separate experiment, as in Fig. 2, on thermosetting materials.

An analysis of energy distribution in the Charpy test is the subject of Table II.

The end-losses are based on Fig. 2 which represents a modification of the procedure of Telfair and Nason (11) who derived end-losses as the difference in impact strength at full swing, and at lowered swing such that the specimen just broke. In Fig. 2 the linear relation allows the end-losses to be expressed in general fashion as foot-pounds per foot-pound of difference between the applied energy and the impact strength of the specimen.

Detailed Analysis of End-Losses:

Note that the procedure above for end-effects requires the assumption that they alone, and not the energy to break the specimen or to deform the machine base, are changing with applied energy (and with velocity). If the end-effect is a kinetic energy, depending on the square of the velocity of the pendulum immediately after fracture, it will now be shown mathematically that the linear nature of Fig. 2 proves that the energy to break the specimen is constant with velocity.

Let indicated impact strength, $I = A + B + C$ where A, B, and C are energies to fracture the specimen, deform the machine and throw the broken ends, respectively. Let U_1, U_2, U_3 be the energies in the pendulum respectively approaching, after the specimen is broken but before the ends are thrown and after the ends are thrown. Assume that $C = kU_3$ where k is a constant (this is equivalent to assuming that end-effects are kinetic and depend on the square of the velocity of the pendulum).

Now,

$$U_3 = U_2 - C \ldots\ldots\ldots\ldots (4)$$

and

$$U_3 = U_2 - kU_3 \ldots\ldots\ldots\ldots (5)$$

since

$$C = kU_3$$

Hence, from Eq. 5

$$U_3 = pU_2 \ldots\ldots\ldots\ldots (6)$$

where p is a constant.
Now,

$$I = U_1 - U_3$$

or, from Eq. 6

$$I = U_1 - pU_2 \ldots\ldots\ldots\ldots (7)$$

If I is linear in U_1 (as in Fig. 2), Eq. 7 requires either that: (*a*) $U_1 - U_2$ is constant, that is, $(A + B)$ is constant with velocity of impact, or (*b*) $U_1 = qU_2 + r$ where q and r are constants.

These two possibilities become clearer if A/B is assumed constant with velocity of impact. This seems reasonable for the brittle thermosetting material of Fig. 2. The first possibility then means that A, the energy to fracture the specimen, is constant with velocity of impact and the second shows that A is a linear function of U_1, that is, of the square of velocity of impact. There is strong evidence that A is constant with velocity for several brittle plastics (7) whereas a linear variation of A with the square of velocity is unknown and the second possibility is thus normally ruled out.

This discussion suggests a rapid method of deducing the partition of energy between the specimen and the machine, that is, $A/(A + B)$, without the need of SR-4 gages. The straight line of Fig. 2 is extrapolated to where ordinate and abscissa are equal. This value is $A + B$. The magnitude of A itself can be determined for similar specimens in a flexure test, provided that there is no velocity effect between 0 ft. per sec. and the range covered by Fig. 2. This is often true for thermosetting compounds. Partitions of energy so determined were in fair agreement with those given by the electric gage.

Special Use of the Charpy Test:

The results of Table II allow the following conclusion: for tough thermoplastics and laminates in thicknesses of $\frac{1}{8}$ in. or $\frac{1}{4}$ in. the measured impact Charpy strength is almost free of the two extraneous energies and is virtually equal to the true impact strength (load-deflection energy). Such thicknesses are those most frequently used in practice for these materials. In this connection, consider an unnotched thermoplastic bar 0.25 in. thick and 0.5 in. wide on a span of 4 in. The Charpy result may be 2 ft-lb. when the applied energy is 3 ft-lb. Of this quantity the energy lost to the

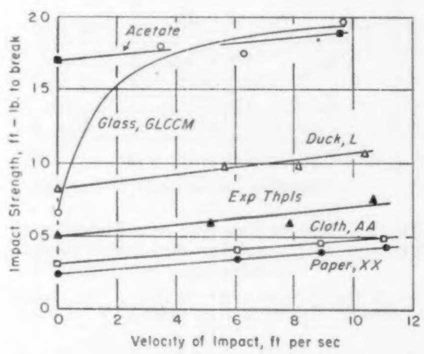


Fig. 3.—Impact Strength as a Function of Velocity of Impact for Various Laminate, Medium Cellulose Acetate, and an Experimental Thermoplastic all Unnotched.
b = 0.5 in., h = 0.12 in., L = 2 in. except for glass laminate for which L = 4 in.

machine is negligible and the end-effect, amounting to 0.02 ft-lb., is also negligible. Two assumptions underlie this example: (1) the end-effect is of the same order for thermoplastics and laminates as for a phenolic material, (2) the partition of energy between specimen and machine does not change from a condition of nonfracture, elastic impact to one of fracture, nonelastic impact. Both assumptions seem reasonable. In regard to the first, one should not be misled by the observation that thermoplastic broken ends often fly ten feet. They do this in the flexure

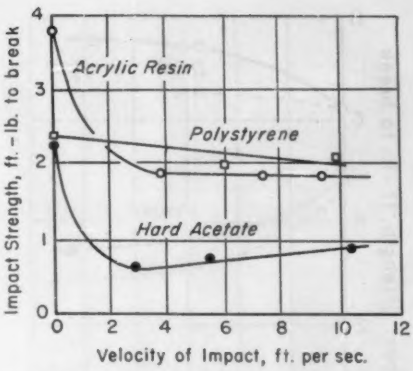


Fig. 4.—Impact Strength as a Function of Velocity of Impact for Unnotched Thermoplastics.
b = 0.5 in., h = 0.25 in., L = 4 in.

test, too, where the end-effect is zero. A release of strain energy explains both incidents. As to the second, energy absorption by the machine tends to be lower as stiffness falls, which it does after the elastic limit is reached and the tangent modulus comes into play.

True Impact Energy:

The Charpy tests for laminates (specimens cut from sheets) and injection molded thermoplastics at various pendulum energies are illustrated in Figs. 3 to 8. The result is assumed to be the true impact energy to separate the specimen into two pieces. On each curve appears a point at essentially zero velocity. This is the area under the flexure curve, expressed in foot-pounds, for separation into two pieces or nearly so. End-effects and machine losses, of course, do not enter in flexure.

The most interesting curves for practical purposes are Figs. 3, 4, and 5. There is usually an appreciable variation of impact resistance between 0 and 11 ft. per sec. With acrylic resin, hard cellulose acetate, and fiberglas laminate the variation is abnormal. Most of it happens between 0 and 4 ft. per sec. Nearly always the impact resistance at 10 ft. per sec. is not more than 25 per cent different from that at 4 ft. per sec. In Fig. 5 the results are questionable because there is energy loss to the machine (about 13 per cent with specimens $\frac{1}{2}$ in. by $\frac{1}{2}$ in. in section). The points have been brought down to allow for this and the corrected results are of interest in comparison with those for similar but thinner specimens in Fig. 3. Figure 5 is the only one based on machine B. Figures 2 to 4 and 6 to 8 are for machine A.

The curves in Figs. 7 and 8 are all for transverse loading, that is, the $\frac{1}{8}$-in. molded thickness has been made the breadth. Such conditions of loading

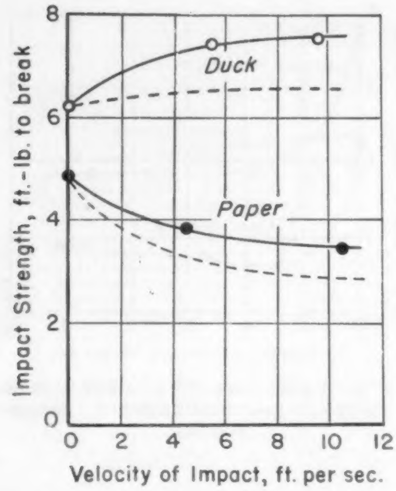


Fig. 5.—Impact Strength as a Function of Velocity of Impact for Unnotched Canadian Laminates in Machine B.

b = 0.5 in., h = 0.5 in., L = 4 in. Dotted curves have been corrected for machine losses.

are not likely in practice for a molded object of $\frac{1}{8}$-in. stock because impact loads would generally be applied transverse to the $\frac{1}{8}$-in. thickness. The laminated specimens of Fig. 7 were cut from the same sheets as those of Fig. 3. The curves are not exactly of the same type in the two conditions. It is difficult to compare energies directly, because while the cross-section is the same, the spans are different, except for fiberglas laminate. In this case the "unnatural" test of Fig. 7 evidently does not yield as high an impact resistance as does the more probable loading of Fig. 3.

The tests of Fig. 6 also simulate an unlikely practical condition. The proper test specimen would have a sharp shallow notch in the sheet face or molded face and the $\frac{1}{8}$-in. dimension would be the thickness. The curves for polystyrene and polyacrylic resin are questionable because end-effects are an important part of the low energies involved. If good design is practiced, notches are rather rare in practice and tests like those shown in Fig. 6 are sufficient to indicate notched impact resistance.

By comparing the impact energies of Fig. 6 with those of Fig. 8 one appreciates the tremendously weakening effect of a notch, and, above all, a milled notch, on polystyrene and polyacrylic resin.

Nearly every plotted point in Figs. 2 to 8 is a mean of 10 determinations. Precision usually fell between ±10 and ±20 per cent at the 95 per cent level of confidence where

$$\text{precision} = \pm \frac{100t}{\bar{X}} \sqrt{\frac{\Sigma(X - \bar{X})^2}{n(n-1)}}$$

and

t = value from t table (2.26 for n = 10),
$\bar{X}$ = mean,
X = individual observation, and
n = number of observations.

The object of this work was to isolate the true impact energy and determine the influence on it of velocity, the notch, and cracking or large deformation. The first-mentioned phases of this program have just been covered. Now comes the question of cracking and large deformation.

Cracking and Large Deformation:

With styrene polymers and acrylic resin there is no problem. The load deflection curve in flexure, Fig. 9, shows some but not much departure from linearity and at maximum load the specimen separates cleanly into two

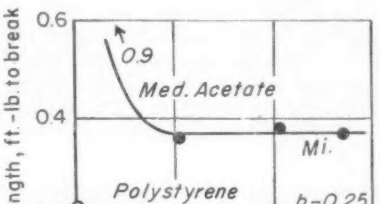


Fig. 6.—Impact Strength as a Function of Velocity of Impact for Notched Thermoplastics.

h = 0.5 in., L = 4 in., b = 0.12 in. for all except as noted. MO = molded notch, MI = milled notch.

pieces. Under impact conditions the load deflection curve is probably similar or there is less "ductility" if the impact energy is much lower than the flexural energy.

With softer thermoplastics such as cellulose acetate the load-deflection curve in flexure may appear as in Fig. 10. The deflection goes on and on and eventually the specimen may fail or be cracked and the load falls to a low level. If the impact energy approaches that for flexure, the load-deflection curves are probably similar. After deformation under impact to X the consumer may consider that the material has failed. A better impact evaluation would be given by the energy corresponding to X than by the total. However, several people would find it difficult to agree on X. The only solution is to accept an impact value based on severance and make a mental reservation that it may overrate the material.

The loading of laminates in flexure often proceeds as illustrated in Fig. 11 (a). Just past the elastic limit a small crack appears in the lower face (under tension) and grows with increasing load. At or near the maximum load there may be an audible warning and the crack suddenly spreads or divides into many others. This critical point is well defined because immediately afterward the load falls rapidly to a much lower level and further load-deflection energy is used in separating the cracked halves. If the load is removed at the critical point and the bar is reloaded, the apparent modulus of elasticity will be lower than the original value, thereby confirming the failure of the bar at the critical point. The significant energy is that to reach the critical point rather than that to sever the bar. With the usual paper and cloth laminates, the severance energy is about the same under impact and flexure loading and there is justification for assuming that the critical energy is the same for both kinds of loading and is more significant than the Charpy energy to cause severance. These remarks apply also to a fabric-filled phenolic compound which shows the critical point, Fig. 11 (b), and the agreement between flexure and impact energy to sever. The critical energy may be as low as one half the energy for severance, whereas in some thicknesses and directions of loading laminates may break clearly, without showing a critical point at all. The proper energy to use is the Charpy value if no critical point is shown.

Fiberglas laminate may exhibit the critical point in flexure loading, but one cannot follow the procedure above for

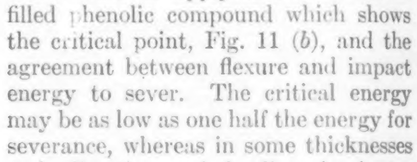


Fig. 7.—Impact Strength as a Function of Velocity of Impact for Unnotched Laminates.

b = 0.12 in., h = 0.5 in., L = 4 in.

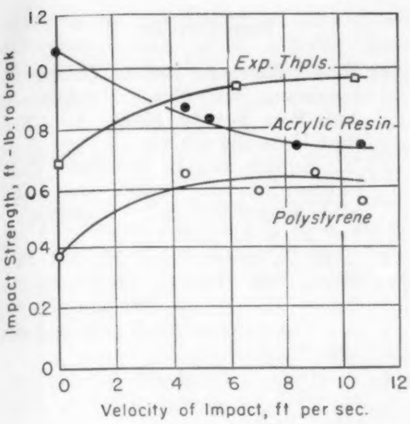


Fig. 8.—Impact Strength as a Function of Velocity of Impact for Unnotched Thermoplastics.

b = 0.12 in., h = 0.5 in., L = 4 in.

determining the significant test energy because the velocity effect is so pronounced. The Charpy severance value overrates the material but has to be accepted.

The use of the flexure curve in providing a definite significant energy to crack is preferable to the alternative procedure of deciding how much impact energy is needed to initiate a crack. There is always debate in deciding when a crack is serious. Further, the condition of the bar under actual load can be examined with some leisure in a flexure test, whereas after impact the cracks have closed up and may appear innocuous.

Conclusions

The following hold for several thermoplastics and laminates:

1. Dynamic and static moduli of elasticity are approximately equal.

2. For thicknesses of $\frac{1}{8}$ in. and $\frac{1}{4}$ in. the Charpy test result is a true impact resistance virtually free of the usual machine losses and end-effects that complicate most impact tests. These thicknesses are those commonly used in plastic objects, and therefore should be those tested.

3. Between rates of loading of 4 ft. per sec. and 10 ft. per sec., true impact resistance usually changes not more than 25 per cent. However, there may be a change of over 100 per cent between 0 ft. per sec. and 4 ft. per sec.

4. Notches, especially if milled, have a tremendous weakening effect on some thermoplastics.

5. Excessive permanent deformation with some thermoplastics may denote failure long before actual severance occurs. It is difficult to allow for this in the Charpy test procedure. Cracking may play the same part with laminates, but interpretation of the flexural and Charpy results together may produce a good value.

Proposed Testing Procedures

The purpose now is to combine the conclusions above with previous knowledge for thermosetting materials and evolve an impact testing procedure for all plastic materials.

One of the chief conclusions from the results presented is that the best impact evaluation can be gained from Charpy and flexure tests on notched and unnotched bars. However, the use of two tests together introduces a flexibility that may be considered undesirable. A more rigid procedure would be to evaluate all plastics in the Charpy test, using notched and unnotched bars. There would be some sacrifice in the quality of the result but certainly the evaluation would be more realistic than the present Izod one. A brief discussion follows of (*a*) the Charpy test, (*b*) the mixed Charpy-flexure test.

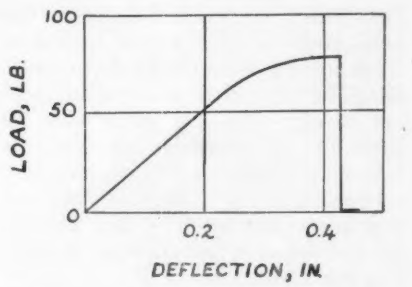


Fig. 9.—Load-Deflection Curves in Flexure for Unnotched Polystyrene, Injection-Molded.

b = 0.5 in., h = 0.25 in., L = 4 in.

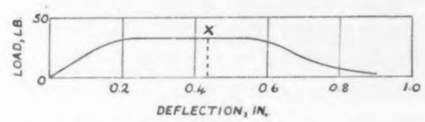


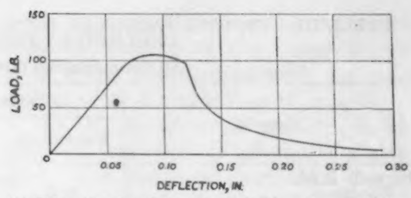
Fig. 10.—Load-Deflection Curves in Flexure for Medium Unnotched Cellulose Acetate, Injection Molded.

b = 0.5 in., h = 0.12 in., L = 2.

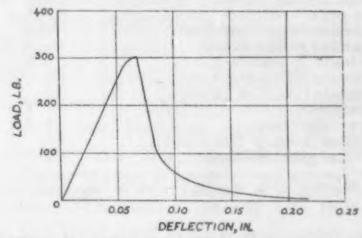
(*a*) *The Charpy Test:*

One advantage of the Charpy test is that, while not much used, it has been on the books of A.S.T.M. since 1926. If used for thermosetting materials in the usual half inch square section and with a span of 4 in. the result would be complicated, but not greatly, by machine losses. The broken-end-effect would bring in a serious error with notched bars of the weaker materials and a lesser error with unnotched bars. Of course, thin bars could be tested too but the properties of thick (that is, $\frac{1}{2}$-in.) bars, molded carefully, are usually a fair reflection of those of thin sections so that there seems no general need for testing thin bars. This is not at all true for thermoplastics, especially when injection molded, so that the test should be made on $\frac{1}{8}$-in. or $\frac{1}{4}$-in. thick specimens, $\frac{1}{2}$ in. wide. When the bar is unnotched the thickness should be the test depth. For a depth of $\frac{1}{8}$ in. the span should be 2 in. to insure fracture, which may not occur on a span of 4 in. with the softer materials. Specimens could also contain a molded notch, of standard dimensions, and the test depth would then be $\frac{1}{2}$ in. minus the notch depth. As remarked before, such a test is unrealistic, but it avoids the trouble of varying notch depth according to thickness. Laminates could be tested in the same way as thermoplastics. For comparison, all results could be expressed as foot-pound per cubic inch (of specimen under stress). For thermosetting materials the result would need no conversion. For a notched thermoplastic, $\frac{1}{2}$ in. deep and $\frac{1}{8}$ in. wide tested on a span of 4 in., the result would need multiplication by four. Such multiplication, of course, is approximate. The variation of machine losses for different dimensions is neglected, and Eq. 2 is assumed to be valid in providing a conversion from one dimension to another. This is only approximate for elastic conditions because breaking strain varies with dimensions, and otherwise may be quite untrue.

Given a list of notched and unnotched Charpy values, there is the question of their reliability for design purposes. The first portion of unreliability enters



(*a*) Fiberglas laminate, b = 0.5 in., h = 0.12 in., L = 2 in.



(*b*) Phenolic resin—fabric, b = 0.5 in., h = 0.5 in., L = 4 in.

Fig. 11.—Load-Deflection Curves in Flexure.

TABLE III.—TYPICAL VALUES OF IMPACT RESISTANCE (CHARPY-FLEXURAL) AND IZOD RESULT FOR COMMON PLASTICS.

All thermoplastics injection molded ⅛ in. thick.

Material	Impact Resistance, ft-lb. per cu. in.				Izod, ft-lb. per in. Milled Notch
	Unnotched	Molded Notch	Milled Notch	Method[a]	
Phenolic Resin:					
Woodflour	0.6	0.07	0.07	A	0.30
Asbestos	0.2	0.04	0.04	A	0.30
Mica	0.1	0.03	0.03	A	0.35
Fabric	0.9	0.8	0.8	A	3.5
Floc	0.6	0.2	0.2	A	0.6
Urea resin—cellulose	0.6	0.05	...	A	0.27
Melamine resin—cellulose	0.6	0.09	...	A	0.28
Melamine resin—fabric	0.5	0.3	...	A	0.8
Laminate L (canvas)	4.6	...	2.5	A	3.8
Laminate XX (paper)	4	...	2	A	2.6
Laminate GLCCM (glass)	17	...	...	B	6.4
Polystyrene	5.7	0.6	0.2	B	0.4
Polyacrylic resin	5.0	...	0.2	B	0.4
Cellulose acetate (medium)	15	...	1.4	B	0.9
Cellulose acetate (hard)	2.5	...	...	B	...

[a] Method A = flexural work to maximum load. Method B = Charpy.

in deciding whether the notched or unnotched value should apply to the problem at hand. The molded object is probably best classified as largely unnotched (for example, a telephone receiver) or largely notched (for example, a box with sharp inside corners) and the appropriate Charpy value is chosen. The value itself is approximate for all the reasons discussed previously and provides design information that is only semiquantitative.

(*b*) *The Mixed Charpy-Flexure Test:*

In the Charpy-flexure method, thermosetting materials would be evaluated by flexural work (to maximum load), thermoplastics by the Charpy value, and laminates by either the Charpy value or flexural work to maximum load. The worth of flexural work for thermosetting materials has been discussed before, especially in two papers (**4**, **7**). Considerations for the Charpy test in respect to dimensions, notching and converting to foot-pound per cubic inch also hold for the Charpy-flexural procedure. To avoid confusion, the result could be called impact resistance. While impact resistance provides a good design figure, it must not be interpreted too closely. Velocity effect and the difficulty of choosing between the notched and unnotched values introduce uncertainties. A difference (95 per cent confidence level) of less than 25 per cent between two materials is probably not significant.

Table III is a comparison between Izod results and Charpy-flexure impact resistance. The latter is more realistic in (*a*) showing distinct differences between mica and woodflour fillers, (*b*) reducing the difference between woodflour and fabric fillers, (*c*) indicating the toughness of polystyrene and polyacrylic resin when unnotched, and (*d*) reducing the apparent superiority of laminates.

Acknowledgment:

Acknowledgment is made of the care and ingenuity with which E. Eugene Stauffer conducted laboratory tests.

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(9) A. W. Koon, "Calculation of a Modulus of Impact," *Modern Plastics*, September, 1945, p. 88.

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DISCUSSION

Mr. Robert Burns.[1]—Once upon a time this discusser took part in a Committee D 20 singing contest. His musical renditions were undeniably beautiful. Equally obvious was the complete lack of artistic appreciaton on the part of the judges. A true description of said judges would require language not quite suitable for the Bulletin which finds its way into the most respectable of laboratories. Anyway, they were forced by public acclaim to confer second prize, some nice plastic playing cards in an attractive plastic case. And it came to pass that the Man Who Should Have Won First Prize was walking through Penn Station some hours later when the second prize dropped accidentally to the tile floor and cracked into many pieces. Nothing is more embarrashing for a plastics expert than to crawl around Penn Station on his hands and knees picking up the dismembered remnants of a Georgeous Plastic Creation.

The plastic was one which, as Messrs. Quackenbos, Hill, and Staff have pointed out, is strong if the designer is careful to avoid notches (sharp corners, etc.). But, alas and alack, he didn't and it wasn't.

Since it is not practicable, nor even desirable, to hang all our designers by the neck until they are completely dead the next best thing is to work closely with them. If in the interests of beauty they want sharp corners, let them have sharp corners, but give them a plastic that will take it. There are enough rounded-corner applications to provide a reasonable market for the low-impact compounds. Certain plastics are brittle, others are strong, and we cannot change that fact by hypnotizing ourselves with scientific double-talk about notches.

The substantial effect of the notch on impact strength, and the desirability of employing a group of tests to evaluate organic materials are not new discoveries but have been brought out by Quack-

[1] Bell Telephone Labs., Murray Hill, N. J.

enbos *et al.* and dusted off with good laboratory data. The authors conclude that Charpy notched and unnotched, in combination with flexural work, will give a truer picture of impact strength than Izod alone. With this there will be little disagreement although it can be argued that Izod could be substituted for Charpy with slight loss. None of us is naive enough to imagine that all of our pendulum-type troubles will disappear by a general change-over to Charpy.

The paper illustrates the solid type of thinking we have come to expect from the boys at Bakelite. They have attempted to place in the hands of the plastics engineer a precise albeit complicated tool for determining impact strength. But Homo Sapiens is a lazy fellow; besides, he must live in peace with his Big Brass. When the excitable Mr. Chief Engineer rushes in with a miserable-looking hunk of junk and asks, with bated breath, "How strong is this?" little Homo will probably run down to his lab and knock off a few specimens on the Izod. It ain't scientific, brother, but it's a living.

Mr. Walter W. Werring.[2]—This paper is another detailed and conscientious exploration of the impact test with a view to its further clarification and explanation. The data presented are complete and valuable.

One is easily tempted to make assumptions about the impact test but it is always dangerous. In the procedure and discussion of end-effects supported by Fig. 2 the authors make some assumptions that end-effects and not the energy to break the specimen change with applied energy (and with velocity) and that the increase in impact value shown is therefore entirely end-effect.

Somewhat at the risk of appearing as Rip Van Winkle in today's busy market place, I should like to suggest that these assumptions are unsupported in the present paper but were examined in my 1926 A.S.T.M. paper referred to by the authors as the start of the impact testing of plastics.

In that paper, tests are reported in which the energy of blow was varied from 2 ft-lb. to 5 ft-lb. but with velocity maintained constant at 11.3 ft. per sec. Those results do not support the assumptions of the present paper. The indicated impact values were practically identical with different energies of blow and the plotted values are with few exceptions horizontal lines. The present authors' Fig. 2 is very different from mine, but in their case "energy of blow" is really not an independent variable though they plot it as though it were.

[2] Member of Technical Staff, Bell Telephone Laboratories, New York, N. Y.

In my early tests, when velocity was varied, definite changes in indicated impact value were shown though at any given velocity the same value was found with energies of blow differing by 100 per cent.

I should like to suggest that these particular assumptions about the effect of energy and velocity which are frequently heard nowadays be examined again experimentally as independent variables in otherwise identical tests and proved or disproved before too much faith is placed in them. The separation of the two variables—energy of blow and velocity—can be fairly readily achieved experimentally, and my early machines were designed to do this. We should not continue to combine these variables in modern tests and separate them only by assumptions in the very area being investigated.

Discussion of Izod *versus* Charpy is a hardy perennial. It should be noted, in considering end-effects, that they may be of somewhat different kinds in the two types of machine. One of the usual objections to the Charpy is the greater interference with the follow-through of the pendulum by the broken ends of the specimen, whereas in the Izod, the end is struck off more cleanly. This can be seen in high-speed moving pictures. This kind of extra end-effect encountered in the Charpy may be irregular and variable with the strength of the material, the type of fracture, material density, elastic characteristics, and perhaps other unpredictable factors.

My own preliminary investigations of end-effects in the Izod are reported in the discussion of the paper "Impact Testing of Plastics" by Burns and Werring in the A.S.T.M. Symposium on Impact Testing, 1938. Tests were made by adding weight to the thrown end of both notched and unnotched bars of phenol plastic. The results, in brief, showed that with the stronger unnotched bars the thrown end could be increased from a weight of 7 g. to 19 g. with no effect on the indicated impact strength, while the notched bars showed a slight effect on increasing from 7 g. to 10 g. and large increases of indicated strength with further increase in weight. These results support the authors' conclusions that with certain materials in certain sizes end-effects can be neglected. For the future, I should like to see a comprehensive investigation of end-effects made by the use of weighted specimens whose characteristics are otherwise unchanged. In such an investigation, I believe the Izod type machine would be more suitable because of the lesser degree of irregular interference with the pendulum after the specimen is broken.

Mr. H. M. Quackenbos, Jr., J. M. Hill, Jr., and C. E. Staff (*authors' closure*).—For the most part, Mr. Burns' remarks cannot be gainsaid. After all he should know something of notches. In 1938 he wrote a paper[3] mentioning a multiple test for impact resistance. He recommended notched and unnotched Izod tests and flexural strength as seeming to correlate best with field experience. He now seems to favor only one test, the notched Izod.

There is one exception to our agreement. We cannot accept the defense of the Izod test over the Charpy test. We have cited facts. Mr. Burns cites none.

On re-reading our paper we have to agree with Mr. Werring. We have not documented properly our assumption that the energy to break the specimen, exclusive of the energy to throw the ends, is constant with velocity. Let us repair this omission. Our most complete data are for a compound resembling that of Fig. 2, except that it contained some cotton floc and was somewhat tougher. It was tested in a drop-weight machine, in which the end-effect is absent, by starting at a low height and increasing the blow about 10 per cent until fracture occurred. By varying the weight we were able to vary the velocity of blow. With 5 notched specimens for each velocity and a span of 4 in., the mean values were:

Velocity of approach, ft. per sec.	2.5	5.6	6.8	8.2	8.4	14.0
Impact strength, ft-lb.	0.106	0.113	0.109	0.097	0.105	0.108

From these and similar data and measurements of strain under both flexural and impact loading we have concluded that phenolic resins in combination with fillers of woodflour, woodflour and floc together, and asbestos, whether the specimens are notched or not, show no detectable change in inherent or true impact resistance over a velocity range from 0 to 14 ft. per sec. The effect is minor with the other common fillers.

Therefore we felt justified in analyzing Fig. 2 as we did, assuming that the change in indicated impact strength with energy of blow arose only from changes in the end-effect. Of course the same pendulum was used throughout in Fig. 2, and energy of blow and velocity of approach varied together.

We, too, have noticed the interference between the broken ends and the

[3] R. Burns and W. W. Werring, "Impact Testing of Plastics," *Proceedings*, Am. Soc. Testing Mats., Vol. 38, p. 39 (1938).

Charpy pendulum. However, this did not appear to be important because several figures, resembling Fig. 2, for various phenolic molding materials (fillers of woodflour and asbestos) all showed a linear relationship. We feel that the Charpy test is so much to be preferred over the Izod test that these slight interferences do not count.

MESSRS. C. H. ADAMS[4] AND D. TELFAIR.[5]—Messrs. Quackenbos, Hill, and Staff have done an excellent piece of work clarifying the significance of the commonly accepted tests for determining the "toughness" of plastic materials. It is recognized by the producer, fabricator, and consumer that "toughness" is one of the most important properties of these relatively new materials, yet one of the most elusive to measure. The authors are to be congratulated for the contribution they have made to a better and more widespread understanding of the impact testing of plastics. Their discussion of the notch effect, of its importance in design and as an aid to the interpretation of impact test results is especially valuable. We were very much impressed with the recommendation that the Charpy test be used on both notched and unnotched bars in preference to the Izod test.

We are particularly concerned about the quotation drawn from reference 7, that is, "A conclusion of this last paper was that in the Izod impact test an astonishing amount of energy, several times that needed to break the specimen, was lost in the machine base." We believe that the relative magnitude of what has been termed "machine losses" has been greatly exaggerated. Quackenbos and Welch determined these by the following indirect method:

1. Measure dynamic strain in the specimen (SR-4 gage and oscillograph method).
2. Assume validity of strain energy equation to calculate "true impact energy."
3. Measure broken-end error.
4. Deduce "machine losses" indirectly by a method of differences: "machine losses" = total energy—(true impact energy + broken-end error).

We have considerable experimental evidence that this method results in large errors in the case of short stubby specimens such as the standard Izod specimen. The method appears to fail in step 2 above because the following strain equation is no longer applicable:

$$U = \frac{1}{216}\, bhLE\epsilon^2 \left(1 + \frac{h^2}{L^2}\right)$$

where:

U = strain energy, cantilever beam, in foot pounds
E = the elastic modulus in psi.,
b, h and L = dimensions in inches, and
ϵ = maximum strain.

The derivation of this equation is based on ideal conditions such as true fixed-end clamping and an ideal stress distribution which neglects local compressive stresses under the point of contact of the striker. The net result is that much more strain energy is absorbed in a short, thick specimen than is predicted by the strain-energy equation. This, in turn leads to too high a figure for "machine losses" and to much too high a ratio of machine losses to true impact energy (or actual strain energy in the specimen).

In fact, if one uses the more slender Charpy specimen the measured flexural energy agrees very closely with the theoretical strain energy and also (for phenolic materials) with the measured impact energy, thus indicating that for this case the "machine losses" have somehow dropped nearly to zero.

Direct measurements indicate that actual losses cannot be much more than 10 per cent for Izod specimens and are much less than this for Charpy specimens.

It is true that Izod impact energy is greater (by 30 or 40 per cent) than the statically measured energy for an Izod specimen loaded in flexure. However, we believe that this difference must be accounted for by the fact that impact conditions of loading are not strictly similar to static loading. For instance, Izod impact appears to proceed as a series of individual blows between striker and specimen,[6] each one of which may absorb a certain amount of energy in the small region of the specimen immediately below its point of contact. This energy is actually absorbed by the specimen and is, therefore, part of its true impact resistance although nothing comparable exists in the case of static loading.

A second point which we feel should be clarified is the statement that, "Dynamic and static moduli of elasticity are approximately equal." This is often the case for the rigid plastics both thermosetting and thermoplastic, but for the softer materials, especially the plasticized vinyls and cellulosics, this relationship is not valid. The difference between dynamic and static moduli may range from 50 per cent to a factor of four or five fold, with dynamic modulus being the higher.

In conclusion, we believe that the authors are to be commended for this important addition to the knowledge on impact testing.

MESSRS. H. QUACKENBOS, JR., J. M. HILL, JR., AND C.E. STAFF (*authors' closure*).—Messrs. Adams and Telfair have discerned a weakness of our first paper (of 1946). We applied the equation for strain energy to Izod impact loading without checking that it held for static loading under the same conditions of very short span. The necessary check was made soon afterward and showed that the original calculated "machine losses" were high. However, on correction they were still heavy and we do not agree with the discussers' statement that "actual [machine] losses cannot be much more than 10 per cent for Izod specimens."

The examination of static loading was made in a standard Izod machine (but not the same machine of our original paper). The pendulum was pulled against the specimen by means of a piece of steel wire. This wire, at one end, was tied to the pendulum near the area of contact with the specimen and passed horizontally to a pulley on the edge of the bench and then vertically down to a loading pan tied to the other end. A dial gage reading to 0.0001 in. was supported in a stand and used to measure deflections in a horizontal direction. The stem of the gage pressed against the back of the pendulum opposite the area of contact with the specimen. Load-deflection readings were taken with the gage stand both on the bench and on the base of the machine. From the slope of the line (P/y), modulus was calculated according to

$$E = \frac{P}{y}\,\frac{4L^3}{bh^3}\left(1 + \frac{h^2}{L^2}\right) \ldots\ldots (1)$$

where the symbols have the usual meaning, b and h each being about 0.5 in. and L being 0.866 in. in this case. The expression in parenthesis allows for shear. Readings were also taken by means of an electric SR-4 gage with its center d from the point of load contact and modulus was calculated from

$$E = \frac{6Pd}{bh^2\epsilon} \ldots\ldots\ldots\ldots (2)$$

where ϵ is strain for load P. The same unnotched bars were also loaded in flexure on a span of 4 in. and modulus was calculated from load and SR-4 strain in the usual way.

The following moduli of elasticity were determined for phenolic resins with the fillers indicated:

[4] Research Department, Monsanto Chemical Co., Springfield, Mass.
[5] Physics Department, Earlham College, Richmond, Ind.

[6] The general theory of impact predicts such behavior.

Method	Modulus of Elasticity, psi.	
	Fabric	Cotton floc
Method A. Dial gage on bench	0.28×10^6	0.26×10^6
Method B. Dial gage on machine base	0.52×10^6	0.47×10^6
Method C. SR-4 on Izod specimen	1.88×10^6	1.28×10^6
Method D. Flexural, 4-in. span	1.50×10^6	1.16×10^6

The difference between the first two moduli A and B means that the whole machine is moved relative to the bench, probably because the connecting screws move slightly or are bent. This movement under load is also detected when the stem of the dial gage is pressed against the edge of the base of the machine. Modulus B is the modulus in static cantilever loading. It should be reasonably close to the modulus D for flexure. That it is not close means that Eq. 1 of this discussion does not hold for such a short span and that the equation for strain energy is at fault. The gravity of the fault can be realized by analyzing the figures in terms of the energy supplied to the pendulum.

Of 100 units of energy applied, $100 \times (0.47-0.26)/0.47$ or 44.7 are used in moving the machine and the rest, 55.3 in deforming the specimen (containing cotton floc) and in other losses. It can be shown that the strain energy, calculated as in 1946 from the SR-4 strain and modulus D, would be $100 \times 1.16 \times 0.26/1.28^2$ or 18.4 units, 1.28×10^6 psi. being modulus C. The difference between the ideal 18.4 units and the real 55.3 units may be attributed to: poor clamping, penetration of the striking edge into the specimen and insufficient allowance for shear in the ideal equation. In loading in a heavy jig in a testing machine we have found a cantilever modulus (corresponding to modulus B) as high as 0.64×10^6. This means that 15 of the 55.3 units may arise from poor clamping. Poor clamping may arise because the specimen is forcing the clamp open and is then rotating in it. Judged by tests at zero span, penetration may account for another 5 units, leaving a residual difference of 16.9, between the real and the ideal, that corresponds to insufficient allowance for shear.

With the fabric material, 46.2 units are consumed in moving the entire machine and of the 53.8 consumed in other ways, 11.9 are given by the ideal strain energy formula.

We have discussed static loading in the Izod machine with a force applied externally. Do the same considerations enter impact loading where the force between the specimen and the pendulum is generated internally? Under a blow insufficient to break (no broken-end error) the two specimens each absorbed 16 per cent of the impact energy applied, calculated from the equation for strain energy. In a different machine in 1946 the corresponding figure was about 20 per cent This 16 per cent is a fair agreement with the 11.9 per cent for the filler of fabric and the 18.4 per cent for that of cotton floc, calculated for the static loading above, when one considers that each result is derived from several measured quantities. The agreement suggests that impact and static loading in the Izod machine may be quite similar. Of course, the similarity cannot be rigidly justified. Messrs. Adams and Telfair mention multiple blows but we believe that this is normally a minor effect (that is, not accounting for more than 5 units of energy in the parlance above) for the phenolic materials.

Thus there are grounds for thinking that the detailed accounting for energy, made with static loading above, holds also for impact loading. To return to this accounting, 18.4 per cent of energy applied goes in ideal flexure, 16.9 per cent in extra shear, 5 per cent in penetration, 15 per cent in poor clamping, and 44.7 per cent in moving the base of the machine. How do these figures bear on the criticism of Messrs. Adams and Telfair? We submit that 18.4 per cent still properly expresses the proportion of energy used in applying flexural stress. The 21.9 per cent covering penetration and extra shear are not really connected with the ability of the material to withstand flexural stress. The 15 per cent for poor clamping can be added to the 44.7 per cent for moving the base to give 59.7 per cent in machine losses.

With this figure of 18.4 per cent in mind we much prefer Charpy loading on a generous span to Izod loading.

Discussion of Paper on Approximate Statistical Method for Fatigue Data[1]

MR. J. W. DUDLEY.[2]—Mr. Peterson's article indicates an excellent approach toward a recommended A.S.T.M. procedure for correlating fatigue data. We suggest that the following objectives should be kept in mind toward this end:

1. Curve fitting by free-hand estimation should be reduced to a minimum if a specification is involved.
2. It would be desirable to fit the data to an empirical equation containing not over three constants or parameters. This equation would then serve to predict the value of stress, S, at any selected value of cycles to failure, N.
3. These constants should bear a definite relation to the endurance limit (horizontal asymptote), so that there will be an objective means of

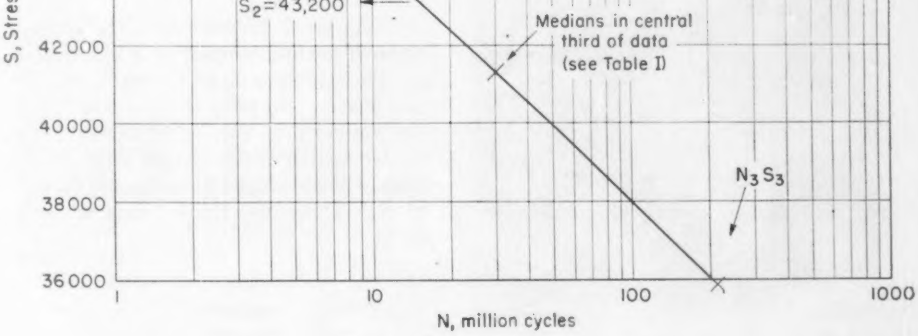


Fig. 1.—Estimation of S_2

[1] R. E. Peterson, "Approximate Statistical Method for Fatigue Data," ASTM BULLETIN No. 156, January, 1949, p. 50 (TP 12).

[2] Chemical Engineer, American Viscose Corp., Philadelphia, Pa.

TABLE I.

N_0 (Observed)	S_0 (Observed)	Medians N_0	Medians S_0	S (Calculated)	$\Delta S = S_0 - S_c$	$\left(\frac{100\,\Delta S}{S_c}\right)$	$\left(\frac{100\,\Delta S}{S_c}\right)^2$
0.102	58 500			55 600	2900	5.21	27.14
0.223	55 000			53 700	1300	2.42	5.86
0.310	53 300			52 900	400	0.76	0.58
0.443	55 000			52 100	2900	5.52	30.91
0.570	50 500	(N_1)	(S_1)	51 500	−1000	−1.94	3.76
0.925	50 900			50 300	600	1.19	1.42
		1.0425	50 000				
1.160	49 500			49 800	− 300	−0.60	0.36
2.690	46 900			47 600	− 700	−1.47	2.16
4.850	45 900			46 100	− 200	−0.43	0.18
6.100	43 900			45 500	−1600	−3.52	12.39
6.750	43 500			45 300	−1800	−3.97	15.76
9.050	41 400			44 500	−3100	−6.97	48.58
9.85	40 600			44 300	−3700	−8.35	69.72
17.6	42 500			42 700	− 200	−0.47	0.22
18.1	41 500			42 700	−1200	−2.81	7.90
18.9	43 000			42 600	400	0.94	0.88
22.9	39 000	See	Fig. 1	42 000	−3000	−7.14	50.98
29.1	42 000			41 400	600	1.45	2.10
		30.25	41 250				
31.4	39 200			41 200	−2000	−4.85	23.52
34.0	41 500			41 000	500	1.22	1.49
44.1	40 500			40 300	200	0.50	0.25
50.5	41 000			39 900	1100	2.76	7.62
71.0	42 000			38 900	3100	7.97	63.52
78.5	39 400			38 700	700	1.81	3.28
96.	40 000			38 100	1900	4.98	24.80
119.	38 400			37 500	900	2.40	5.76
126.	35 700			37 300	−1600	−4.29	18.40
129.	34 300			37 200	−2900	−7.80	60.84
131.	38 100	(N_3)	(S_3)	37 200	900	2.42	5.86
207.	36 000			35 900	100	0.28	0.08
		210.	35 850				
213.	37 400			35 800	1600	4.46	19.89
215.	34 000			35 800	−1800	−5.03	25.30
232.	36 000			35 600	400	1.12	1.25
445.	33 000			33 700	− 700	−2.08	4.03
446.	32 000			33 700	−1700	−5.04	25.40
680.	34 400			32 400	2000	6.17	38.07
		$N_2 = (N_1N_3)^{1/2} = 14.8$	$S_2 =$ (from Fig. 1) 43 200			53.62 −66.76 −13.14 Avg. −0.365	610.26 Avg. 16.96 v = 4.12 per cent

predicting from the data whether such a limit exists.

We believe that these objectives may be attained by using the equation $S = B + A/N^m$, where S and N are the stress and cycles to failure, respectively. The constants or parameters are A, B, and m. When the fitted data in-

TABLE II.—CALCULATION OF CONSTANTS A, B, AND m.

S = stress, psi.
N = cycles/10^6
$S = B + A/Nm$

Selected Data	N	S
(1)......	1.0425	50 000
(2)[a].....	14.8	43 200
(3)......	210.	35 850

[a] $N_2 = (N_1N_3)^{1/2}$ for simplified calculation:

$$B = \frac{(S_1S_3) - (S_2)^2}{S_1 + S_3 - 2S_2} = \frac{(1792 - 1868)10^6}{-550}$$

B = 138,200 psi.

$$C = \frac{S_1 - B}{S_3 - B} = \frac{-88{,}200}{-102{,}350} = 0.862$$

$D = N_3/N_1 = 201$

$$m = \frac{\log C}{\log D} = \frac{-0.0645}{2.3032} = -0.028$$

$A = (S_1 - B)N_1^m = (-88{,}200).\ (0.999) = -88{,}100$

Calculation check: $B = 138{,}200$
$+A/N_2^m = -95{,}000$
$S_2 = 43{,}200$

Simplified equation: $S = 138{,}200 - 88{,}100\,N^{0.028}$

dicate that these constants are all positive, the value of B will then be the endurance limit, corresponding to a curve which is concave upward when plotted like Fig. 1.

Using Mr. Peterson's data, the application of the above equation is illustrated in the accompanying Tables I and II and Fig. 1. In most data of this type, the value of N_2 will be relatively close to the median of the central third of the data, when arranged in increasing values of N. Therefore, the amount of free-hand estimation required by this method is practically negligible.

In the data given by Mr. Peterson, the three medians form nearly a straight line on semi-log graph paper. This line is slightly concave downward, and the negative values of A and m indicate that no endurance limit can exist.

There appears to be little advantage to calculating "projected values" of stress if an empirical equation is fitted to the data, since the equation itself can be used to calculate S at any selected value of N. Also, the standard deviations of each of the three groups of data in the above example appear to be fairly constant, so that there seems to be no advantage to calculating coefficient of variation instead of standard deviation. We have used coefficient of variation, however, to compare the the goodness of fit with Mr. Peterson's method. The coefficient of variation may be of considerable value with other sets of data where values of S have a higher relative variation. Since the data are so nearly linear on semi-log paper, it will be noted that the goodness of fit is nearly the same by either method.

The final calculated values may also be checked for assignable causes of variation by the control chart method as illustrated in Table III. There is some indication that this particular set of data is remarkably short in the "tails" of the distribution. Possibly some of the more erratic data may have originally been discarded by Moore and Jasper. At any rate, no assignable causes of variation are indicated by the control chart or by using the method of quartile analysis given in "Examination of Industrial Measurements," Dudley, McGraw-Hill, 1946.

TABLE III.—CONTROL CHART FOR $100(S_0 - S_c)/S_c$.

Subgroup	X_1	X_2	X_3	$\overline{X}$	R
1..........	5.21	2.42	0.76	2.797	4.45
2..........	5.56	−1.94	1.19	1.603	7.50
3..........	−0.60	−1.47	−0.43	−0.833	1.04
4..........	−3.52	−3.97	−6.97	−4.820	3.45
5..........	−8.35	−0.47	−2.81	−3.877	7.88
6..........	0.94	−7.14	1.45	−1.583	8.59
7..........	−4.85	1.22	0.50	−1.043	6.07
8..........	2.76	7.97	1.81	4.180	6.16
9..........	4.98	2.40	−4.29	1.030	9.27
10..........	−7.80	2.42	0.28	−1.700	10.22
11..........	4.46	−5.03	1.12	0.183	9.49
12..........	−2.08	−5.04	6.17	−0.317	11.21
Averages..........				−0.365	7.111
Upper limits*..........				6.90	18.3
Lower limits*..........				−7.64	0

* Control with "No Standard given."
Estimated Standard Deviation = $\overline{R}/d_2$ = 7.111/1.693 = 4.2 per cent.

Magnesium Alloys and Applications

John C. McDonald[1]

Editor's Note.—This is a digest of the talk presented at a meeting on light metals and alloys held at Massachusetts Institute of Technology, Cambridge, Mass., April 14, 1949, under the auspices of the New England District. Another of the talks on "Aluminum" by R. L. Templin was published in the May ASTM Bulletin.

The metals discussed in the papers on the program of this meeting are fittingly described as "light," in comparison to steel or copper. The approximate ratios of their densities to that of steel are: titanium, three-fifths; aluminum, one-third; and magnesium, one-fourth. Their industrial histories are similar only in respect to their youth as compared to steel. While the metallic aluminum industry in this country is over 60 yrs. old, magnesium has been produced for only half that period. Similarly, our infant, titanium, is now starting out with about the same relation in time to magnesium, namely, with the magnesium industry about thirty years old. The purpose of this paper is to summarize the characteristics of magnesium which have led to its present-day uses and to outline briefly what some of those applications are.

Magnesium is the lightest of the three light metals under discussion and also has the lowest modulus of elasticity. It is an interesting fact that the ratio of density to modulus of elasticity is approximately the same for these three metals and is also approximately the same as that of steel. Since the modulus of elasticity is a measure of rigidity, it follows that structures in one of the lighter of these metals can be made as rigid as structures in a heavier one only by increasing dimensions. For many important types of loading in structures, however, such as bending, the rigidity increases as the third power of the increase in dimensions of the parts. Equal rigidity may, therefore, be achieved at a saving in weight. However, in the case of all these metals, the strength of the basic material must be increased by alloying additions in order for the structures to have useful load bearing and service characteristics. The commercial alloys developed for magnesium contain aluminum as the chief alloying ingredient. Zinc and manganese have been used to a lesser extent. Recently, experimental alloys have come into the picture in which zinc and zirconium are the major alloying constituents. Cerium is likewise being used experimentally to produce alloys particularly suitable for use at elevated temperature.

The commercial magnesium alloys, like the aluminum alloys, are available today in all of the standard forms—sand castings, permanent mold castings, die castings, extrusions, forgings, and sheet. Such products may be handled in fabricating shops like any other metal. Ease of machining is high and formability is exceptional when the metal is heated. Cold forming operations are limited because of the hexagonal crystal structure of magnesium.

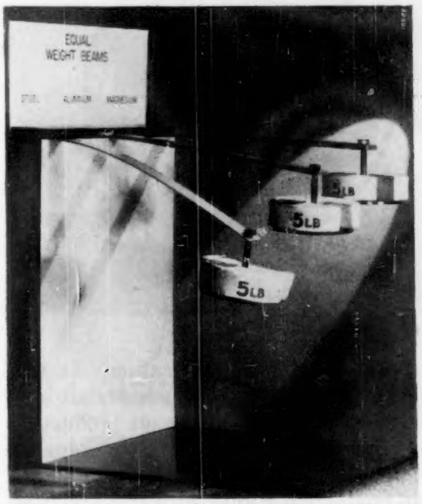


Fig. 1.—Comparative Rigidity of Equal Weight Beams.

Some of these standard forms are available today at prices competitive with other metals. This is particularly true of extrusions and die castings. Where a price premium is required, the peculiar advantage of magnesium, its lightness, has sufficed to provide large-scale uses. Before describing some of these applications, we should consider in greater detail some of the consequences of the combination of low density, rigidity, and strength which magnesium alloys have.

Magnesium is well suited for the manufacture of articles in which the simplest possible kind of design is desired. Rigidity and strength of these parts are provided by using greater thickness of section than would be used with heavier metals. Such sections have high resistance to bending and compression load because of the "beef" thus provided in the structure. At the same time, the cost of the actual construction may be lowered because the less complex structure avoids, among other things, a multiplicity of connections. Such structures can do a good job of sustaining their design loads, and are rugged. They will withstand excessive service abuse. Relatively larger amounts of energy can be absorbed without a permanent set being produced. Numerous recent instances of wrought magnesium truck bodies which have been involved in accidents have illustrated this point. The bodies have required only minor repairs before replacement on another chassis. In another interesting experiment, a cast automobile wheel weighing half as much as a similar wrought steel wheel showed very slight permanent set in the rim, whereas the rim of the steel wheel under the same impact had been badly distorted.

Under normal conditions of atmospheric exposure, magnesium alloys become covered with a thin gray surface coating. There is little loss in weight or impairment of properties. A casting in

Fig. 2.—Deep Drawn Box Drawn Hot in One Operation.

[1] Assistant Technical Director, Magnesium Division, The Dow Chemical Company, Midland, Mich.

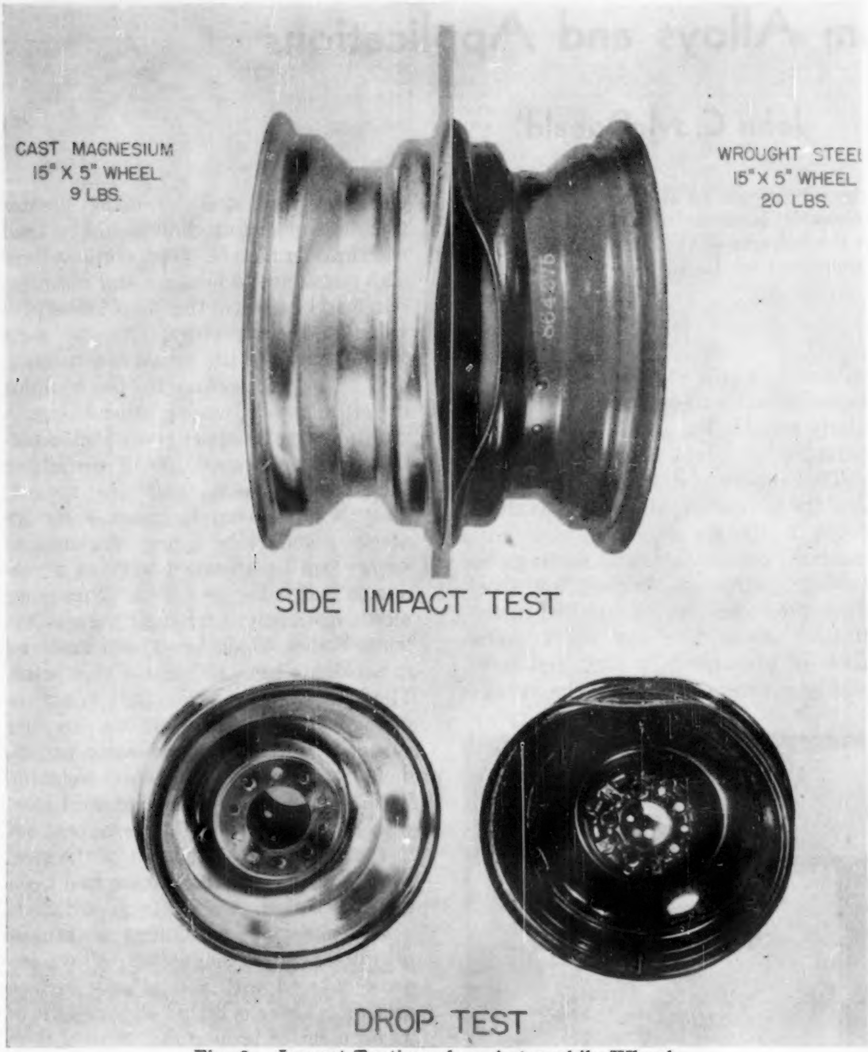


Fig. 3.—Impact Testing of an Automobile Wheel.

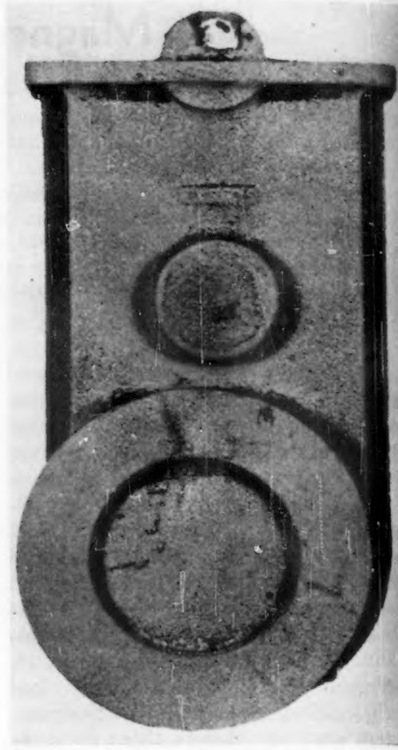


Fig. 4.—Surface Appearance of Magnesium Casting, 22 yr. Exposure, Industrial Atmosphere.

the industrial atmosphere of Midland has now been on exposure for 22 yr. with scarcely any visible change in appearance. In moist saline environments, however, the high electric potential of magnesium produces a battery action with most other metals with which it may be in contact. This reaction produces a dissolution of the magnesium. If the heavier metals are contained as discrete particles, as impurities within the magnesium, local cells create a similar corrosion effect. Alloys are now available in which the heavy metal impurities are controlled at such a level that this phenomenon no longer occurs. However, in the interest of good surface finish, it is usually recommended that magnesium be protected with a good paint system. Also, salt water exposure conditions require the use of good insulating measures between the magnesium and most other metals.

Because of its lightness, magnesium is a preferred material of construction in all articles which have to be lifted or moved constantly. This naturally makes the transportation industry an ideal place for its application. In this field, one of the biggest uses to date is in aircraft. Airplanes now in production and being designed use considerably larger quantities than those which were in production during the war. The B-36 is an outstanding example of such use, as is also the Navy's XF7U. A number of the civilian airplanes are also making use of magnesium's characteristics in a variety of ways. Use in truck bodies is coming into increasing prominence. There is a very large variety of applications for magnesium in the portable tool and machinery fields. Space forbids any detailed consideration.

This discussion would not be complete without some mention of uses for metallic magnesium other than the structural. Such uses are of an electrochemical, chemical, and metallurgical nature.

The high electric potential of magnesium mentioned above is deliberately made use of in systems for cathodically

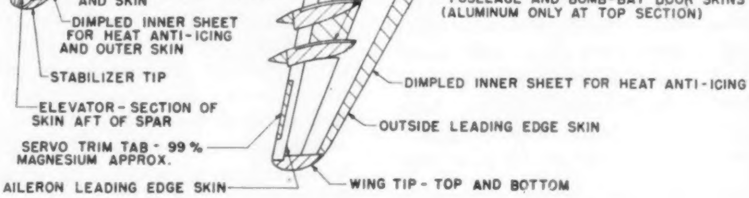


Fig. 5.—Location of Magnesium in the B-36.

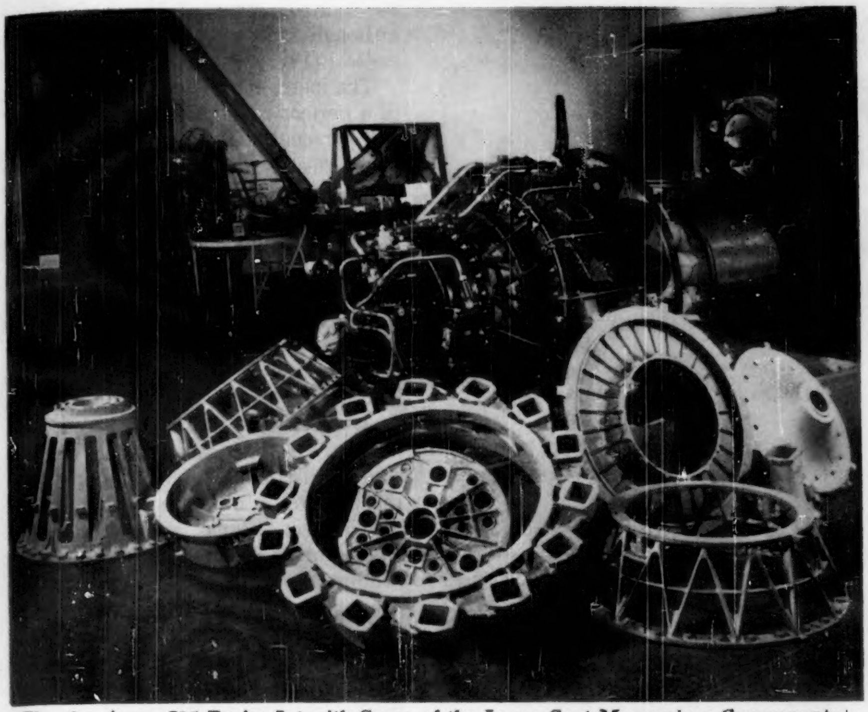


Fig. 6.—Army J35 Turbo Jet with Some of the Large Cast Magnesium Components.

protecting steel structures. This has found application for pipe lines, structures exposed to sea water, and in protecting domestic water heaters. Another application whose success has depended on the development of a magnesium alloy with suitable etching characteristics, is the photoengraving plate. This is an increasing application in which both the light weight and good etching characteristics of magnesium have proved of value. Another field in which a large consumption is expected is that of primary cells. Experimental work to date indicates the possibility of production of highly efficient batteries using magnesium as one of the agents.

In the chemical field, the chief use of magnesium is in the synthesis of certain organic chemicals through the Grignard reaction. This is a purely chemical effect which does not require the use of a magnesium alloy.

Among the metallurgical applications for metallic magnesium—one which is currently attracting much attention—is the production of ductile cast iron. Addition of magnesium to gray iron appears to nodularize the graphite in such a way that good values of toughness and strength are obtained. At the same time a desulfurization is produced. As an alloying agent with aluminum, very considerable quantities of metal are consumed.

In conclusion, the magnesium industry in America today stands on firm ground and is ready greatly to expand this field of application. This expansion will take place not only through its structural use but also because of its interesting metallurgical, electrochemical, and chemical applications.

A Direct Reading Portable Photoelectric Photometer for Determining Reflectance of Highway Centerlines

By John M. Hill[1] and Howard W. Ecker[1]

The development of a reflective centerline marking material by our organization required a means of evaluating properly the reflection obtained with various beaded materials as compared to conventional highway striping paints.

The photometer described herein is a modification of a laboratory device made by the New Jersey Zinc Co.[2] It can be used on the highway in daylight for evaluating night brightness of highway centerline stripes. This direct reading instrument allows comparison of remotely located stripes to be made easily. The effect of operator fatigue is eliminated since an unskilled operator obtains the reflectance value from a meter in less than two seconds.

The instrument consists of a miniature light source which illuminates a small section of the area being examined. This light source is mounted at a position in the instrument analogous, on a reduced scale, to that of the headlight of an automobile on a highway. A photocell is located in a position equivalent to that of an automobile driver's eye. The output from the photocell actuates a meter to indicate the reflective value. A self-contained battery provides power for the light source and photocell circuit. A reflectance standard is an integral part of the instrument. This standard is normally in a position similar to that occupied by the test area. Movement of a lever repositions the standard so that the optical system examines the surface upon which the photometer rests. The all-metal instrument is built as a rigid framework to prevent any shifting of the optical elements, aluminum being used almost exclusively in order to keep the weight as low as possible.

The miniature reproduction of highway centerline viewing conditions was dictated by the physical dimensions of the light source, photocell, and containing case, and, so as not to make the instrument too bulky, we restricted our photometer field to a distance not to exceed 100 ft. ahead of an auto. We have adopted 33 in. as standard automobile headlight height and 57 in. as standard height for the driver's eyes A range of 50 to 100 ft. (75 ft. average) was selected for our reduced scale instrument. The angle of incidence at 75 ft. is 87 deg. 54 min. (87.9 deg.) and the angle of reflection is 86 deg. 23 min. (86.38 deg.). The angle of divergence will be about 1 deg. 30 min. (1.5 deg.) (Fig. 3).

It should be noted that normal center-

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] "Scotchlite" Division and Engineering Division, respectively, Minnesota Mining and Manufacturing Co., St. Paul, Minn.

[2] H. A. Nelson and S. Werthan, *Industrial and Engineering Chemistry*, Vol. 18, p. 965 (1926).

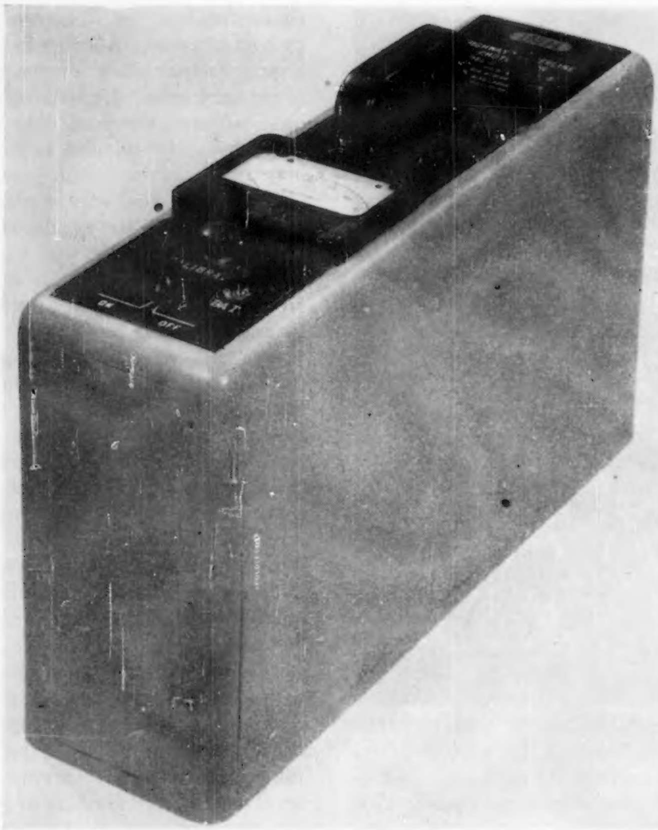


Fig. 1.—Photoelectric Photometer.

line viewing conditions are somewhat indeterminate for many reasons. Both "bright" and "tilted" light beams are used in night driving. The driver of an automobile automatically raises his line of sight as his speed increases, and, at high speed, he views the centerline several hundred feet away on a straight gradeless highway. Grades and curves require reflecting qualities at distances closer to the automobile. The angles mentioned are on the assumption of the headlights, driver's eye, and the stripe being all in the same plane, which of course is not the case. If the driver is assumed to be, say, normally 24 in. to the right of the stripe, further complexity is introduced. The Purkinje effect, a sensitivity characteristic of the human eye, is another factor. This effect is such that the standard luminosity curve for daylight vision is no longer applicable for low light levels such as those encountered in night driving. With very low illuminations the eye increases greatly in sensitivity to blue and violet, but is unchanged to red,[3] as is shown in Fig. 4.

Fortunately, checks on highways and laboratory experiments show the brightness per unit intensity of centerlines, roadbeds, and magnesium oxide to be reasonably constant at viewing distances of more than 50 ft. ahead of the automobile (Fig. 5). The spectral sensitivity of the system was adjusted to approach that of the human eye, although it too was found to be not critical (Fig. 6).

The instrument is calibrated in terms of a perfectly diffusing white surface of 100 per cent diffusing reflecting factor. (A perfectly diffusing surface is one which emits radiation according to the cosine law.) This theoretical surface has been assigned the value of unity.[3] Almost all materials reflect considerable light at grazing angles, even though they may be poor reflectors when viewed perpendicularly. McNicholas has made many tests over a broad range of lighting and viewing angles.[4] Our tests show that the commonly used magnesium oxide, whose light-reflecting characteristics are similar to those of the "perfect white" for 45 deg. normal viewing conditions, has a value of 2 when examined under centerline viewing conditions at a distance of 75 ft. ahead of an automobile.

Another difficult problem in *any type of reduced size photometer* of this nature is the effect of stray light. Bead-type materials reflect a large portion of the incident light back to the source while diffusely reflecting materials reflect light at all angles. If this random reflected light from diffusely reflecting materials is allowed to be reflected from the walls inside the instrument to the sample, it increases the light to a point above the intended illumination intensity. Since perfect absorption is unattainable, we have in effect a higher light intensity on diffus-

[3] D. R. Griffin, R. Hubbard, and G. Wald, *Journal Optical Society America*, Vol. 37, p. 546 (1947).

[4] H. J. McNicholas, *Journal of Research*, Nat. Bureau of Standards, Vol. 1, p. 29 (1927).

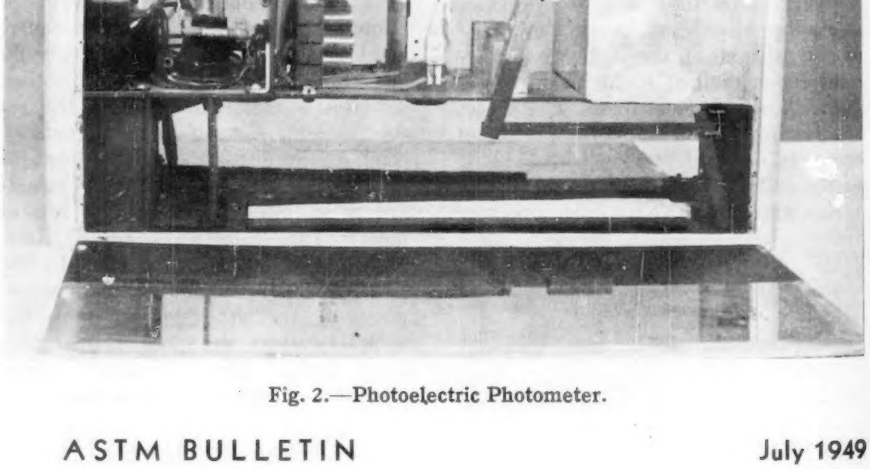


Fig. 2.—Photoelectric Photometer.

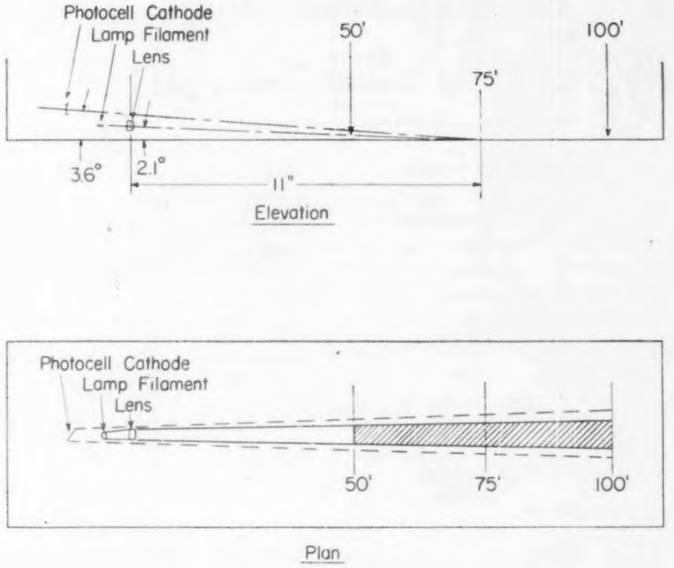


Fig. 3.—Simplified Drawing of Optical System.

Shaded area indicates light pattern on sample. Photo-cell can see area outlined by dashed lines which includes all the lighted area.

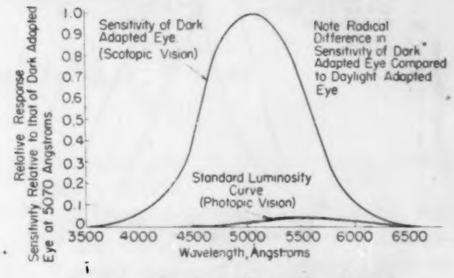


Fig. 4.—Eye Sensitivity Curves N.

ing materials than on beaded materials. This error favors paint by giving an instrument reading that is higher than desired. The magnitude of this error is such that on samples having relative directional reflectance[5] of 16.5 to 1 (874 beads *versus* MgO) (Fig. 5), our instrument shows a value of 14.7 to 1. Our instrument has a direct reading scale starting at zero that covers the complete range from plain paint through colored beaded centerline to white reflecting centerlines. At present, it is theoretically exact at 2 and reads 22.2 at a true value of 25. This error could be shifted to the low range if desired. A true reflectance of 2 would then read 2.2.

The light source is a small tungsten bulb operating at 2.3 v. A current regulator tube is used to prevent changes in voltage from affecting the intensity or color. This light source is operated at approximately the same color temperature as an automobile head lamp.

A No. 1P21 electron multiplier phototube supplied with 1000 v. d-c. was required to measure the low densities of reflected light flux. The voltage for the phototube is regulated by means of a series of small gas-filled voltage regulator tubes.

The instrument is powered with a small 6-v. "Aircraft," non-spill-type battery which allows more than one thousand readings to be taken before recharging is necessary. This battery is exposed by removing four screws holding the rectangular top cover plate at the end of the instrument. A charger furnished with the photometer, is equipped so as to plug into the receptacle in the end of the photometer case. A battery test push button is provided on the instrument panel. When this button is depressed, the meter indicates the charge condition of the battery. In order to obtain the high voltage for the phototube, a power supply similar to that used in automobile radios is used. A vibrator applies alternating current to the primary of a special transformer.

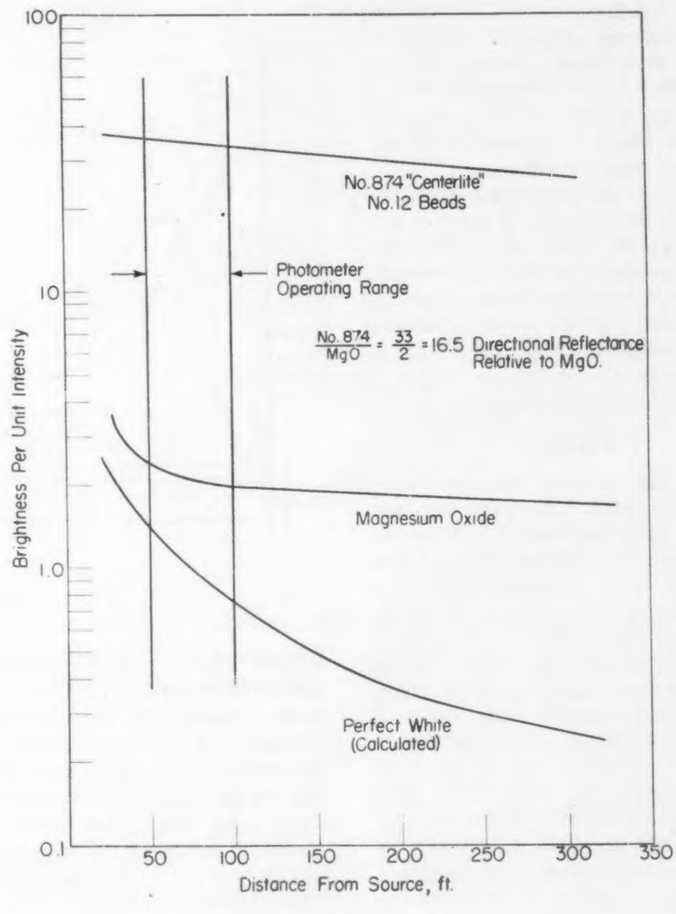


Fig. 5.—Brightness Records.

[5] Committee on Colorimetry, *Journal Optical Society America*, Vol. 34, p. 256 (1944).

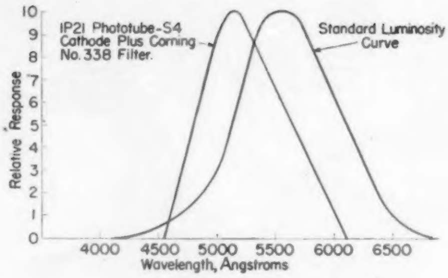


Fig. 6.—Spectral Response Curve.

The high-voltage a-c. output of the transformer secondary is converted to d-c. by means of two filament type rectifier tubes. This voltage of approximately 1000 v. d-c. supplies a total load of about 2 ma. The 2-ma. load is largely that of the voltage regulator tubes. A current sensing relay has been provided in the high-voltage circuit so that if the regulator tubes are not operating properly the instrument is inoperative. The wiring diagram is shown in Fig. 7.

In order to use the photometer, it is necessary to operate the switch and adjust the "calibrate" knob until the meter pointer rests at the position on the scale marked "set." This reading on the internal standard should be checked periodically during a long series of tests. The reflectance reading of the stripe is obtained by pulling the "exposure handle" forward while the instrument is on the test area.

Reflectance standards are furnished with the instrument. These standards provide a means of checking the over-all response of the instrument. These are provided so that a maladjustment caused by shock or relamping may be detected. Mechanical adjustments inside the instrument allow a new lamp to be located properly.

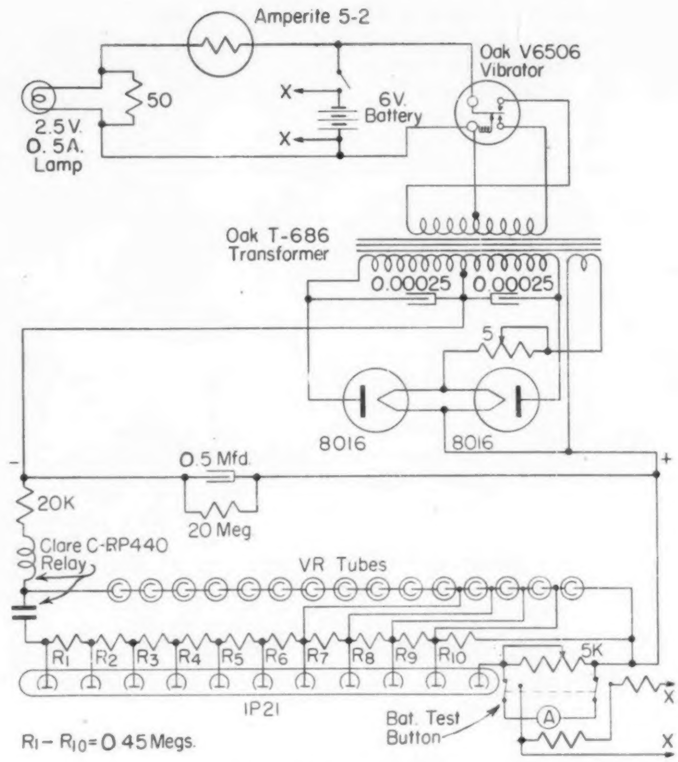


Fig. 7.—Wiring Diagram.

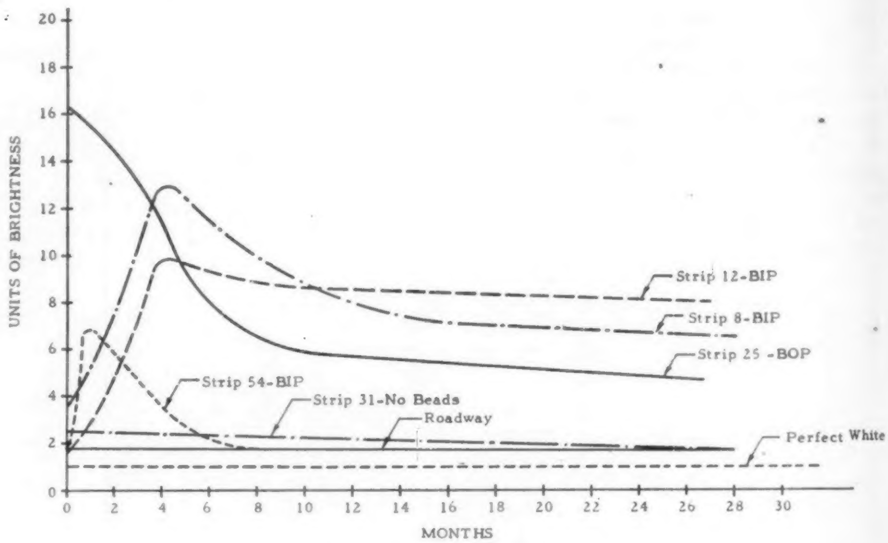


Fig. 8.—Comparison Graph.

Results

About one million readings have been made with this unit to date. Readings have been taken in temperature ranges from 20 to 100 F. The lamp has been replaced only once during this period. Figure 8 shows the aging characteristics of *five* striped lines as checked with this device. These five lines were a part of a test section where traffic volume, road surface, and application methods were identical.

User's Comments

Favorable comments have been received from various highway engineers throughout the United States who have used this instrument. They state that it consistently reproduces readings and eliminates the errors present in non-direct-reading instruments. They also cite the decreased hazard to the operator while using this device. The operator stands in an upright position and does not kneel to obtain the reading.

Acknowledgments:

We wish to express appreciation to Delbert Olson and Martin Olson of Minnesota Mining who collected data and made the many models necessary to establish the final design.

We are indebted to L. B. Paist, R. Marchant, and E. P. Davis who served us as consultants.

Improved Single-Unit Schiefer Abrasion Testing Machine[1]

By Herbert F. Schiefer,[2] Lawrence E. Crean,[2] and John F. Krasny[2]

THE experimental machine initially constructed to produce uniform abrasive action over a surface and from every direction in the plane of the surface, in accordance with the mathematical solution[3] for obtaining uniform abrasion, demonstrated very definitely the soundness of this type of machine. It was found desirable, however, to construct a much more rigid machine in order to maintain parallel alignment of the two axes of rotation. In redesigning the machine several other improvements were made which facilitate the testing, adapt the machine for testing a greater variety of materials, and increase the range of testing conditions. The new machine described in this paper meets these requirements very well.

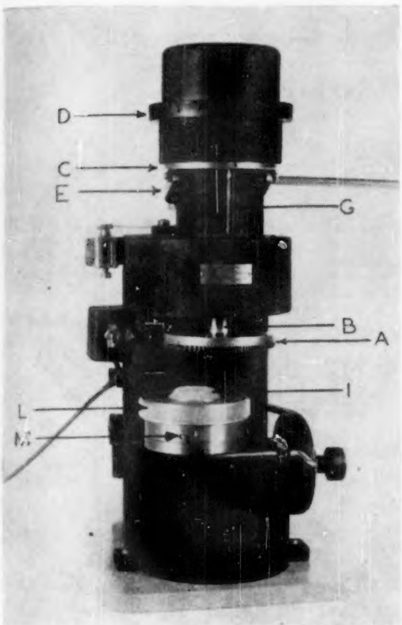


Fig. 1.—Schiefer Abrasion Testing Machine Ready for a Test.

Description of Machine:

The general appearance of the improved single-unit Schiefer abrasion testing machine is shown in Fig. 1. The specimen is in constant contact with the abradant during a test. The specimen and the abradant rotate in the same direction and with approximately the same angular velocity, 250 rpm., each about its own axis. These axes are spaced 1 in. apart and are parallel. The framework of the machine is a single heavy rigid casting. Ample interior space is provided for gears, which can be inserted through small openings in the rear of the casting. The schematic drawing in Fig. 2 shows the arrangement of the gears and the several rotating shafts to produce the rotation of the specimen and the abradant. Each shaft rotates in two ball bearings. The gears of one shaft are primed thereby making the shafts rotate at slightly different speeds. This speed difference prevents one and the same element of the abradant from acting on one and the same area of the specimen during each rotation.

Different kinds of abradants, A, can be attached to the bottom of the abradant shaft, B. The abradant surface lies in a plane perpendicular to the shaft axis. This shaft has two keyways cut lengthwise for the entire length of the shaft. It can be moved vertically through a bushing, which forms the rotating shaft of the gear that is driven by a gear fastened to the auxiliary drive shaft. To the top of the abradant shaft is attached, through radial and thrust ball bearings, an aluminum cap, C, which serves as support for adjustable weights, D, to produce constant pressure of the abradant on the specimen throughout the test. A yoke, E, actuated by a cam, F, is provided for raising or lowering the abradant. A key on the inside of the aluminum cap can slide in a vertical keyway, G, of the main casting and keeps the cap and weights from rotating.

To the top of the specimen shaft is attached a presser foot which fixes the area

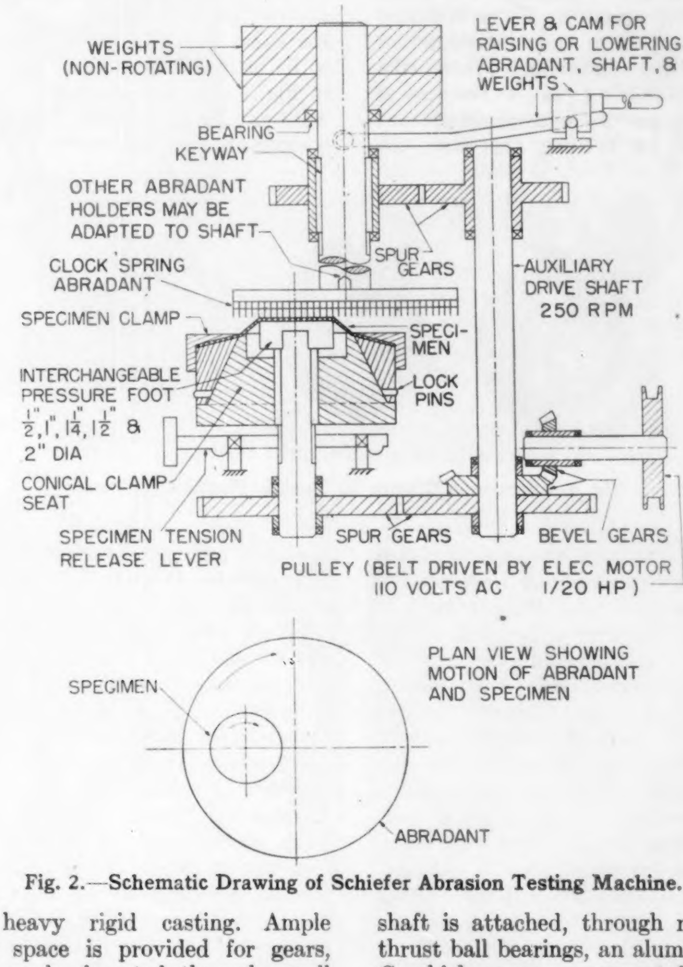


Fig. 2.—Schematic Drawing of Schiefer Abrasion Testing Machine.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to A.S.T.M. Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] This condensation is published in the ASTM BULLETIN because of the broad interest and application to the work of the A.S.T.M. Committees. The complete paper appeared in *Journal of Research*, Nat. Bureau Standards, Vol. 42, May, 1949. (*RP* 1988.)

[2] Principal Physicist, Associate Engineer, and Assistant Physicist, Textile Section, National Bureau of Standards, Washington, D. C.

[3] Herbert F. Schiefer, "Solution of Problem of Producing Uniform Abrasion and Its Application to the Testing of Textiles," *Journal of Research*, Nat. Bureau Standards, Vol. 39, pp. 1–10 (1947) (*RP* 1807); *Textile Research Journal*, Vol. 17, July 1947, pp. 360–368.

of the specimen, I, that is abraded. Different sizes and shapes can be used. In the upper portion of the specimen shaft are cut two keyways. A conical clamp seat with two keys is fitted to the specimen shaft and rotates with it. It can move freely, vertically, on the shaft. A cam is provided at the bottom with two ball bearing contacts for raising the conical clamp seat. The clamp, L, holding the specimen fits on the conical seat and can be fastened to it by two lock pins, M, by merely rotating the clamp slightly. The clamp and specimen can be removed quickly in the same simple manner for examination and measurement of the amount of wear. The specimen can then be returned to the machine without disturbing its position in the clamp and the abrasion test continued. In testing textiles, the specimen, I, is mounted in the clamp in a relaxed state under reproducible conditions. When the specimen clamp is locked to the conical clamp seat and the conical clamp seat is lowered by turning the cam, the evenly and securely. When the clamp is lifted from the template the specimen is in the prescribed relaxed state. The twofold reason for mounting the specimen in this relaxed state is to obtain even circumferential tension on the specimen and to provide enough material so that the portion of the specimen which is in contact with the presser foot projects sufficiently above the clamp for the abrasion test. It is obvious that other types of specimen clamps can be used for testing nontextile materials. Figure 3 shows clamps for testing small cylindrical specimens of plastics and other solid materials.

Abradants:

Different abradants may be used interchangeably in the machine. The abradant, A, in Fig. 1 consists of closely spaced parallel spring steel blades, the edges of which have been ground to lie in the same plane. Abradant A in Fig. 4 is similar except that notches were cut in the blades. Abradant B is similar to the latter except that thicker

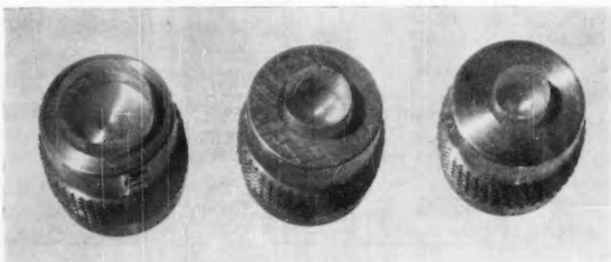


Fig. 3.—Specimen Clamps for Testing Plastic Cylinders.

combined weight of the conical clamp seat and specimen clamp is suspended by the specimen over the presser foot fastened to the top of the shaft. This places the specimen under constant tension throughout the test with take-up of any stretch of the specimen. Different tensions can be obtained by varying the weight of the conical clamp seat or by the addition of auxiliary weights. It is apparent that the shaft, presser foot, conical clamp seat, specimen clamp, and specimen rotate as one unit under the described conditions.

The successive steps for mounting a circular textile specimen are important. The lower half of the clamp is placed over a template with an adjustable hub projecting a given distance through the center of the clamp. The circular specimen is placed centrally over the hub and the annular conical ring is placed on top of the specimen so that the recess cut in the rim of the ring registers with a pin in the lower half of the clamp. The upper half of the clamp is then screwed to the lower half, thereby clamping the specimen

blades of high-speed tungsten tool steel were used. Abradant C consists of 397 small rods of carboloy, the ends of which were ground to lie in the same plane. A similar abradant was used in some tests in which pyrex glass rods were used in place of carboloy. It is planned to make others in which rods of high-speed tungsten tool steel and synthetic sapphires will be used. An adapter has been constructed in which duck, cloth, sandpaper, emery paper, and similar abrasives may be used. The abrasive is mounted under uniform tension and in a plane at right angles to the axis of rotation. Obviously many other types of abradants can be used, depending upon the kind of test desired and upon the kind of material being tested.

Typical Worn Specimens:

Specimens of woven fabric, fleeced knitted fabric, pile fabric, coated fabric, coated glass fabric, graph paper, leather, plastic, and printed enamel floor covering have been tested. The wear on all of these materials was extraordinarily uniform over the abraded area. The print of graph paper, for example, could be worn off without tearing the paper. The woven fabrics are of special interest. The tests on them were discontinued when one set of threads (warp or filling) was completely worn away, with the other set of threads still intact as shown in Fig. 5. Figure 6 shows abraded areas above the knee of two trouser legs. Examination of

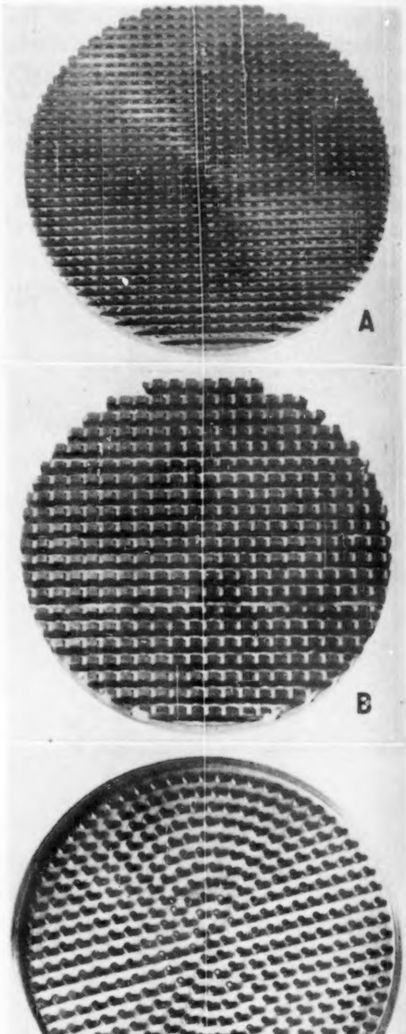


Fig. 4.—Interchangeable Abradants.

A, cross-cut spring steel blade abradant.
B, cross-cut high-speed tungsten tool steel abradant.
C, carboloy rod abradant.

worn garments indicated that the wear shown by these trouser legs is typical of the abrasive wear of woven fabrics in service. The striking similarity of the abrasion obtained with the machine and in service is evident.

A special application of the machine described is for evaluating the effect of wet cleaning solutions on printed

enamel felt-base floor coverings. The specimen is placed at the bottom of a shallow cylindrical cup and the cleaning solution is placed on it. The abradant used is a nylon-bristle brush. Some of the floor coverings tested had good resistance to washing with soap and soda solution at 45 C. Others like the one shown to the right of Fig. 7 were poor in this respect.[4]

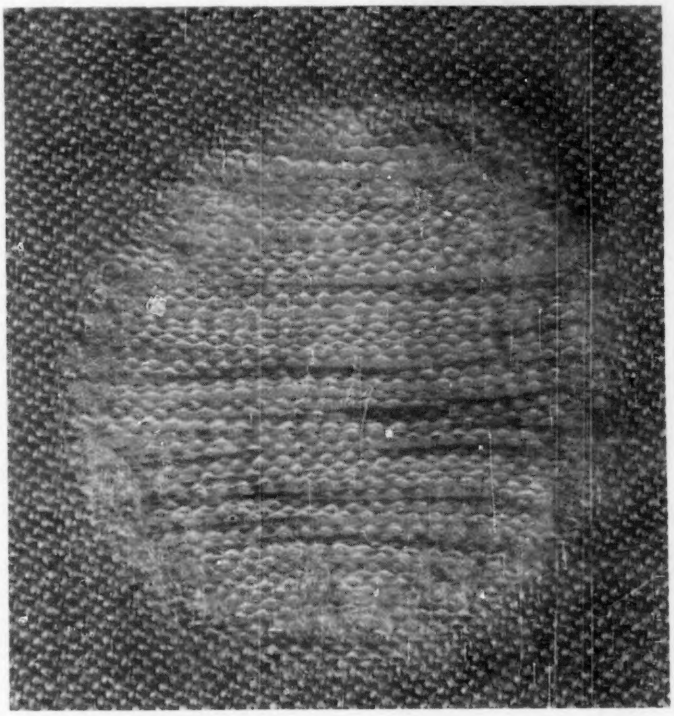


Fig. 5.—Magnified Appearance of an Abraded Woven Specimen.

Quantitative Method for Measuring Abrasion of Fabrics:

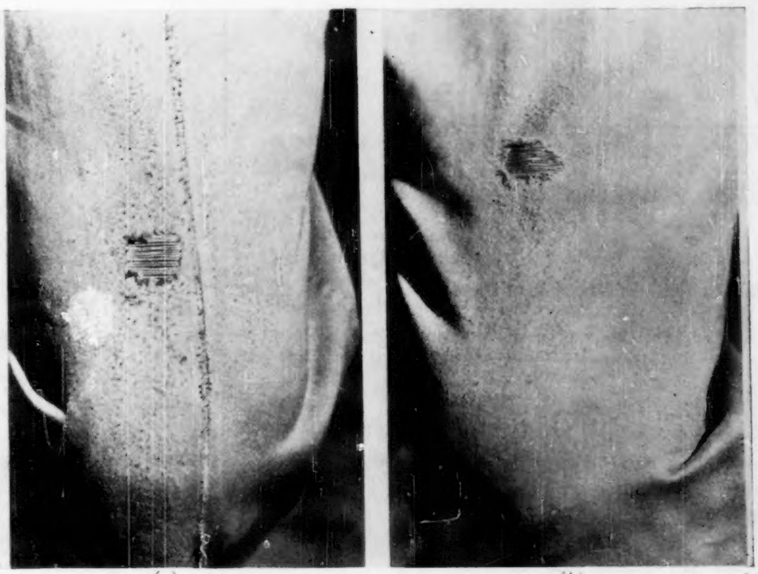
Consideration was given to a quantitative measurement of the amount of abrasion during a test. This measurement should not disturb or affect the specimen and should be simple, rapid, and sufficiently sensitive. The capacitance method described below seems to meet these requirements.

A capacitor,[5] shown schematically in Fig. 8, was attached to a capacitance test set which is normally used to measure the capacitance between the electrodes of vacuum tubes. The set operated at a frequency of 465,000 cycles per second. The capacitor is of the guard ring type. The island electrode, C, is 1 cm. in diameter. The outside diameter of the annular guard ring electrode, B, is 3 cm. The island and guard ring were so constructed that the specimen clamp, D, from the abrasion machine could be readily inserted in the capacitor in such a manner that the clamp was suspended by the worn area of the specimen, A, over the island and guard electrodes. The third electrode, E, is mounted in a heavy hinged lid, F, which can be swung down to a fixed stop after the specimen and clamp are inserted. This third electrode forms part of a micrometer head for adjusting the distance between it and the island electrode to precise known values. The construction of the capacitor is very heavy and rigid.

The measuring procedure consists in adjusting the distance between the electrodes to a value slightly in excess of the thickest specimen to be tested. The capacitance C_0 with the unworn specimen in the capacitor is measured and also the capacitance C_a of the air without a specimen. The specimen is then abraded for R rotations against the abradant in the abrasion machine and the capacitance C_R of the abraded specimen is measured. The value Q is then computed by means of the formula

$$Q = \frac{C_0 - C_R}{C_0 - C_a} \times 100$$

It can be taken as a measure of destruction or ruin by abrasion, expressed as a percentage. If a number of values of Q are obtained for various values of R, a wear curve can be obtained by plotting Q against R as shown for fabrics A and B in Fig. 9. For comparative testing, some function of R, such as $\log_{10}R_{50}$ where R_{50} is the number of rotations for which Q is 50 per cent, is suggested as a suitable criterion or wear index. It is believed that this index would correlate well with service test results. This confirmation will of course have to wait until adequate service and laboratory wear test results are available. The supplier of fabrics A and B stated that fabric B was definitely superior to fabric A according to service performance of these two fabrics.



(a) (b)

Fig. 6.—Abraded Areas of Two Trouser Legs.

The application of the capacitance measurements for evaluating quantitatively the abrasive wear of garments is of special interest. The trouser leg shown in Fig. 6(b) was opened along the

[4] This photograph was obtained from George G. Richey who carried out this research at the National Bureau of Standards.

[5] Dr. Charles Moon of the National Bureau of Standards suggested the essential design features of this capacitor.

inside seam and a very large number of capacitance measurements were made of the area shown in Fig. 6 (*b*). For each measurement a value of Q was computed using as a value of C_0 that which was obtained for the least worn area. These values of Q were accurately plotted according to the position of each measurement. From these plotted values of Q it was very easy to chart the iso-ruin lines of the parameter Q as shown in Fig. 10. By comparing this iso-ruin map with the actual photograph in Fig. 6 (*b*), it can be seen that Q closely approximates the value of 50 per cent in several areas where the one set of threads is practically worn away. The comparison is of course much more striking and convincing by a direct comparison of this iso-ruin map and the actual fabric. It is worth mentioning that a simple capacitance device could be arranged for obtaining the iso-ruin map of trousers without the necessity of opening any of its seams. This would allow the trousers to be worn again after each evaluation of the amount of wear from the iso-ruin map.

The iso-ruin map technique can also be used to explore the uniformity of a fabric, especially of the distribution of finishing agents in a fabric which are moisture sensitive. Variations in the yarn number, ends and picks per inch, twist of the yarns, and amount of sizing affect the weight of the fabric in 1-cm. diameter areas and also the amount of moisture contained in these areas. Changes in the latter affect the capacitance values greatly.

Application for Evaluating the Effect of Plasticizer on Resistance to Abrasion of Plastics:

Small cylinders of cellulose acetate butyrate containing various percentages of dibutyl sebacate were abraded using abradant *A* of Fig. 4. The cylinders were 0.5 in. long and were

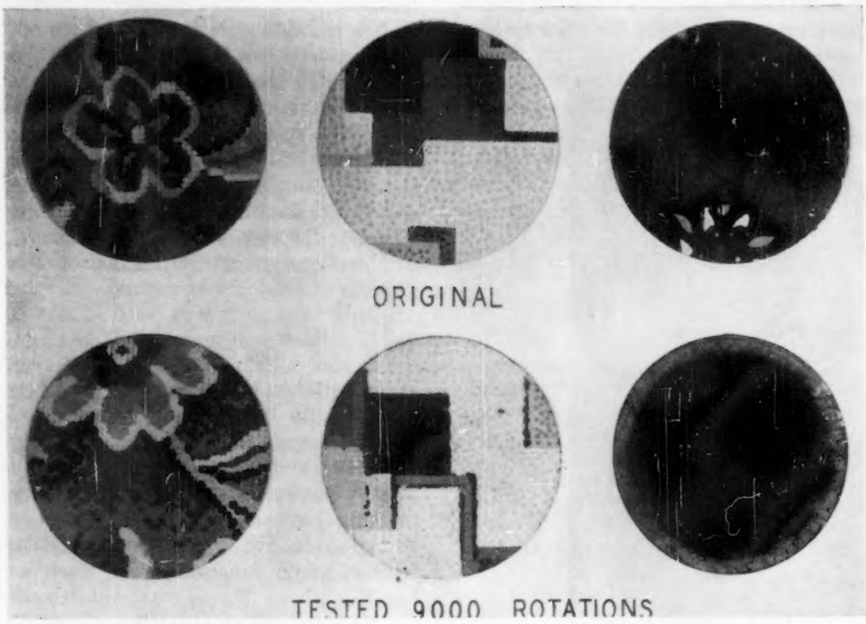


Fig. 7.—Specimens of Printed Enamel Felt-Base Floor Covering Before and After Test for Resistance to Detergents.

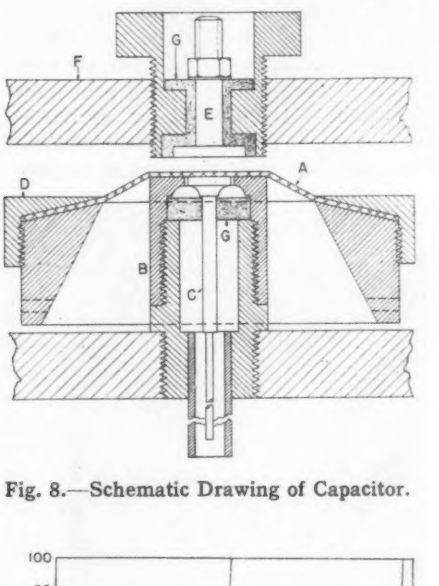


Fig. 8.—Schematic Drawing of Capacitor.

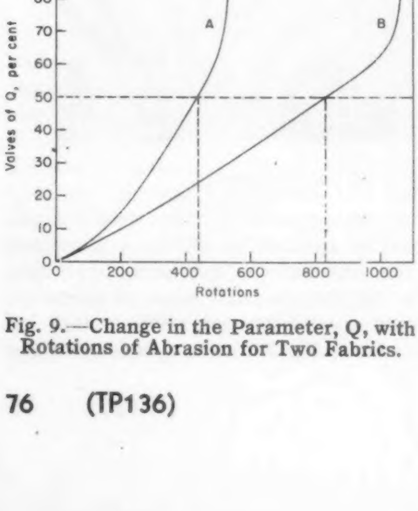


Fig. 9.—Change in the Parameter, Q, with Rotations of Abrasion for Two Fabrics.

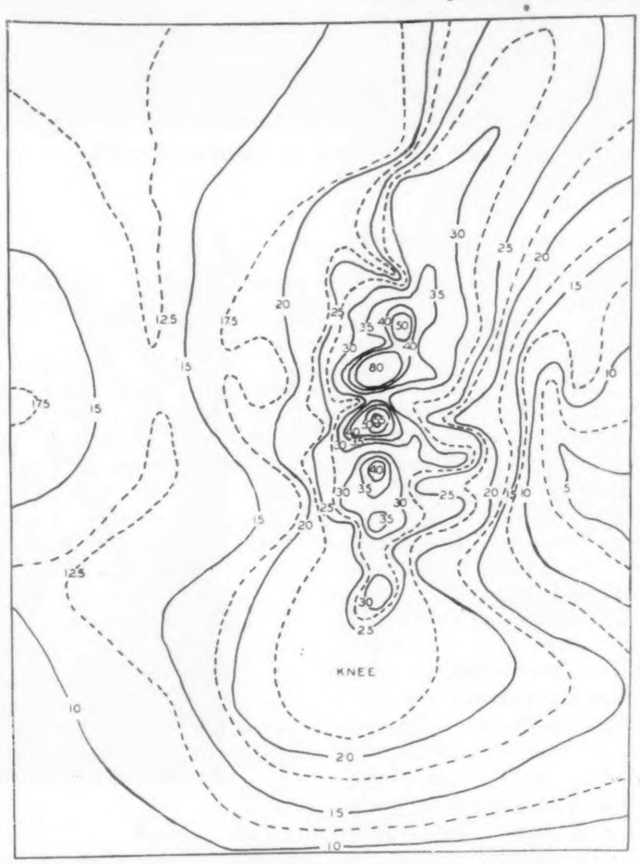


Fig. 10.—Iso-ruin Map of Worn Trouser Leg, B, Fig. 6.

machined to a diameter of 0.450 in. The specimen holder shown in Fig. 3 was used. The weight and thickness (length of cylinder) were measured before the test and at regular intervals during the abrasion test. The decrease in thickness is plotted in Fig. 11 against the number of rotations the specimen was in contact with the abradant. The effect of the amount of plasticizer on the resistance to abrasion was readily measured. The decrease in

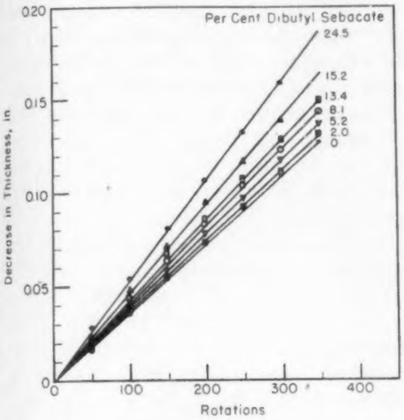


Fig. 11.—Relation Between Decrease in Thickness and Rotations of Abrasion of Cellulose Acetate Butyrate Containing Varying Amounts of Plasticizer.

thickness per 100 rotations is plotted against the amount of plasticizer in Fig. 12 and shows that the rate of abrasion increases directly with the amount of plasticizer. The decrease in weight of all of the separate measurements is plotted against the corresponding decrease in thickness in Fig. 13. The points lie very close to a straight

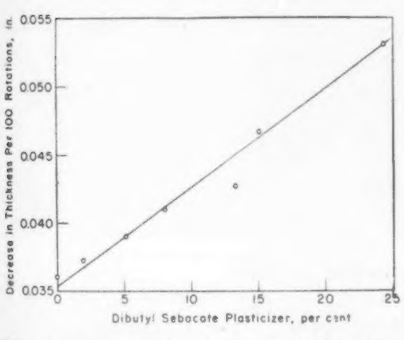


Fig. 12.—Rate of Abrasion of Cellulose Acetate Butyrate as Measured by Change in Thickness per 100 Rotations.

line. This indicates that for these plastics the rate of abrasion is equally well measured by change in thickness and change in weight and that the end of each plastic cylinder is abraded evenly and uniformly.

Effect of Abrasion Tests on the Abradant:

Some abradants are considerably affected or changed during an abrasion test. This is particularly true when abrasive papers, abrasive cloths, and fabrics are used as abradants and is shown by the results for 17 fabrics in Table I. Five successive tests were made of each fabric with the same piece of carborundum waterproof abrasive paper. This procedure was repeated four times. A value in the second column, 58 ±3 for example, is the average number of rotations to destruction and standard error of five specimens of fabric No. 1, each tested with a new piece of abrasive paper. A value in the third column, 110 ±5 for example, is the average number of rotations to destruction and standard error of five specimens of fabric No. 1, each tested with a piece of abrasive paper that had already been used for testing a specimen of this fabric. A value in the fourth column, 127 ±7 for example, is the average number of rotations to destruction and standard error of five specimens of fabric No. 1, each tested with a piece of abrasive paper that had already been used for testing two specimens of this fabric. The values in the fifth and sixth columns were similarly obtained. In other words, before the fifth specimen of a fabric was tested with a piece of abrasive paper, the piece of abrasive paper had been used for a number of rotations which was equal to the sum of the number of rotations of the first, second, third, and fourth tests. The great decrease in the abrasive power of a piece of this abrasive paper is at once obvious, especially at the beginning of a test with a new piece of abrasive paper, as can be seen by comparing the values in the second and third columns. Because of this great change in the abrasive character of these types of abradants, it is customary to test only one specimen with each piece of abradant. In some work, where a test lasts a long time, the piece of abradant is periodically replaced by a new one or the abradant surface is redressed with a more severe abradant. Although this procedure may seem best under these conditions, actually the results obtained may be misleading. For example, it would be erroneous to conclude that fabric No. 8 is twice as resistant to abrasion as fabric No. 1. It is clear from the values for fabric No. 1 that after 58 rotations for the first test the abrasive power has dropped to about one-half so that 110 rotations are required for the second test. A similar change in this abradant is

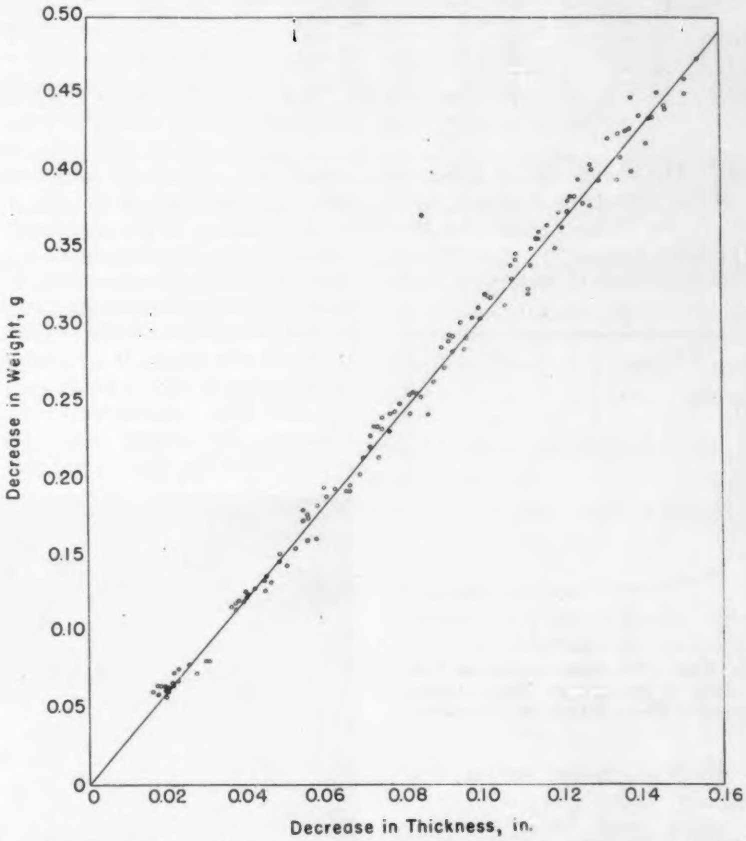


Fig. 13.—Relation Between Decrease in Weight and Decrease in Thickness of Cellulose Acetate Butyrate in Abrasion Tests.

produced for each of the other 16 fabrics. Also it can be seen from the standard error that the variability of the abrasive power of a piece of abrasive paper increases with use, the standard error for the second test is on the average more than twice as great as for the

TABLE I.—EFFECT OF FIVE SUCCESSIVE TESTS WITH SAME CARBORUNDUM WATERPROOF ABRASIVE PAPER ON ABRASION RESULTS OF DIFFERENT FABRICS.

Fabric	Rotations of Abradant to Destroy Specimen: First Test	Second Test	Third Test	Fourth Test	Fifth Test
No. 1.....	58 ± 3	110 ± 5	127 ± 7	133 ± 7	132 ± 5
2.....	77 ± 5	134 ± 16	186 ± 19	187 ± 13	196 ± 15
3.....	84 ± 3	127 ± 5	147 ± 11	166 ± 12	149 ± 6
4.....	90 ± 6	158 ± 9	174 ± 10	193 ± 12	189 ± 19
5.....	92 ± 6	181 ± 17	213 ± 18	230 ± 10	215 ± 14
6.....	104 ± 5	221 ± 20	260 ± 17	292 ± 26	306 ± 48
7.....	110 ± 4	252 ± 20	301 ± 26	278 ± 27	322 ± 55
8.....	115 ± 4	252 ± 7	278 ± 9	290 ± 7	290 ± 9
9.....	126 ± 9	228 ± 18	276 ± 33	302 ± 21	287 ± 16
10.....	135 ± 4	253 ± 6	274 ± 11	272 ± 12	281 ± 11
11.....	135 ± 10	311 ± 29	354 ± 32	401 ± 38	398 ± 29
12.....	138 ± 4	299 ± 8	345 ± 14	371 ± 10	395 ± 7
13.....	143 ± 4	298 ± 18	335 ± 8	342 ± 9	391 ± 22
14.....	145 ± 13	500 ± 73	708 ± 166	887 ± 125	1105 ± 279
15.....	152 ± 5	417 ± 20	505 ± 23	540 ± 40	591 ± 22
16.....	193 ± 6	494 ± 27	563 ± 22	686 ± 76	866 ± 71
17.....	475 ± 29	1231 ± 145	2106 ± 229	2119 ± 105	2747 ± 760

first test. The change in the abrasive power of the abradants during a test probably is the primary cause for the erratic results frequently reported in interlaboratory testing and conducted

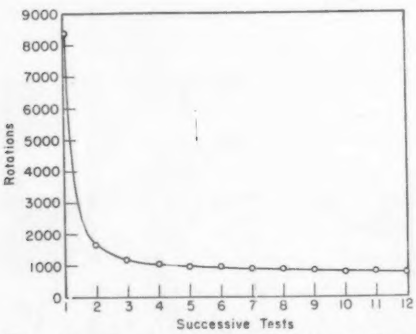
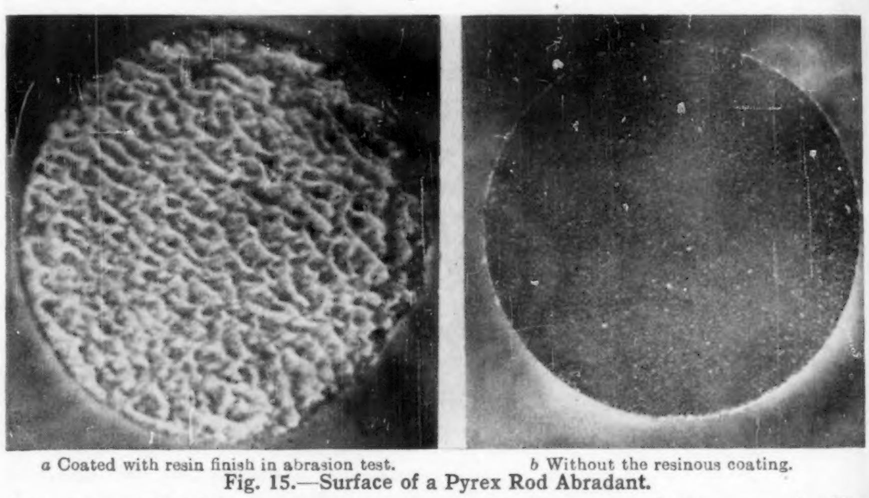


Fig. 14.—Curve Showing Increased Rate of Abrasion in Successive Tests Owing to Deposit of Resin Finish on Abradant.

under otherwise similar testing conditions.

The spring steel blade abradant shown in *A* of Fig. 1 has been used for over a million rotations on a large number of cotton fabrics. It was found that in these tests the action of the abradant changed less than 3 per cent in over a hundred thousand rotations, which was much less than the variation between specimens taken from any one of these fabrics. For comparative testing of several fabrics this abradant can be considered to remain constant.

It is of interest to report the results of an entirely opposite effect on the abradant which was observed with one fabric. Instead of the usual decrease in the abrasive power of the abradant, in this case the abrasive power was greatly increased, that is, successive specimens were worn to destruction in fewer rotations as shown in Fig. 14. The first specimen tested required over 8000 rotations and the second one required less than 2000. After the third specimen the rate of abrasion was nearly constant and about ten times the initial rate. It was found that a resinous substance on the fibers stuck to the surfaces of the abradant. This substance was thermoplastic and apparently very sticky, so that the frictional force between this substance on the abradant and the fibers of the specimen was many times greater than between the clean abradant and specimen and therefore increased the rate of abrasion. The same result was obtained when the pyrex glass rod abra-



a Coated with resin finish in abrasion test. *b* Without the resinous coating.

Fig. 15.—Surface of a Pyrex Rod Abradant.

dant was used. The appearance of the end of a coated and an uncoated pyrex glass rod is shown in Fig. 15. Although the effect described cannot be ascribed to a faulty operation of the abrasion machine or of the abradant, nevertheless it is apparent that erroneous conclusions can be drawn if the operator of the machine is not an alert and critical observer.

Summary:

An improved single-unit Schiefer abrasion testing machine was developed. It can be adapted for testing a great variety of materials under a wide range of test conditions. Different types of specimen holders and abradants can be used with the machine. Both the pressure and tension on the specimen can be fixed at selected values and maintained constant throughout the test period. A variety of materials including woven, knitted, pile, and coated fabrics, felt, plastics, paper, leather, and other materials were abraded with the machine. The abrasive wear of each material was found to be extremely uniform over the abraded area. The effect of wet cleaning solutions on printed enamel felt-base floor coverings was evaluated. The effect of the amount of plasticizer on the resistance to abrasion of plastics was readily measured. The rate of abrasion was directly proportional to the amount of plasticizer present. The abrasive wear in tests of woven fabrics appeared very similar to that which occurred in service. A quantitative method based upon the change in electrical capacitance of the specimen with abrasion was described for evaluating the amount of abrasion. A quantity which is a measure of abrasive destruction or ruin was defined. This quantity was used to obtain an iso-ruin map of a large area of a trouser leg. This iso-ruin map showed very clearly a number of areas at which excessive wear in service had occurred. The change of the abradant during abrasion tests was discussed. Carborundum paper, a generally used abradant, decreased very greatly in abrasive power. The spring steel blade abradant remained essentially constant, although in testing one resin-finished fabric, the surfaces of this abradant became coated with the resinous substance, which greatly increased the abrasive power.